MACHINERY

JULY, 1913

FLOATING REAMER-HOLDERS

DESIGNS TO INSURE CONCENTRICITY OF WORK IN HORIZONTAL AND VERTICAL MACHINES

BY ALBERT A. DOWD*†

At first glance nothing is more simple than a reamer-holder which is so made as to permit the reamer to float in any direction. Yet if this is so simple why are there so many types of so-called "floating holders"? All of these must have some special claim to efficiency as a reason for their existence. In order to properly discuss the question, we must first see clearly that there is a necessity for a holder of this type, by analyzing the conditions governing its use, taking as an example a piece of work to be machined in a horizontal turret lathe.

Let us assume that the hole is first carefully generated with a single-point boring-tool held in the turret. It should then be absolutely concentric about the axis of rotation and ready for the reamer. If the reamer is so held that its centers are coincident with this axis and is fed into the work in this position, the resulting hole should be true and of the correct size. Unfortunately, however, machines of this type are subject to slight variations in their indexing, and the inevitable wear upon the ways produces a certain amount of inaccuracy which must be taken care of in some way in the reamer-holder, in order that the reamer may be unrestrained in following the generated hole produced by the boring-tool. It is now apparent that there is a very good reason for the floating type of holder for reamers used in turret lathe work. The problem consists in selecting from the many varieties a holder which will allow the reamer to follow the generated hole without restraint, even when the turret holes are considerably out of alignment with the spindle.

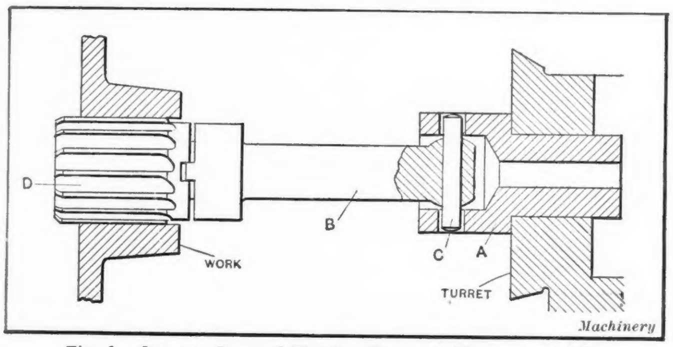


Fig. 1. Common Form of Floating Reamer-holder supported by Ball and Pin

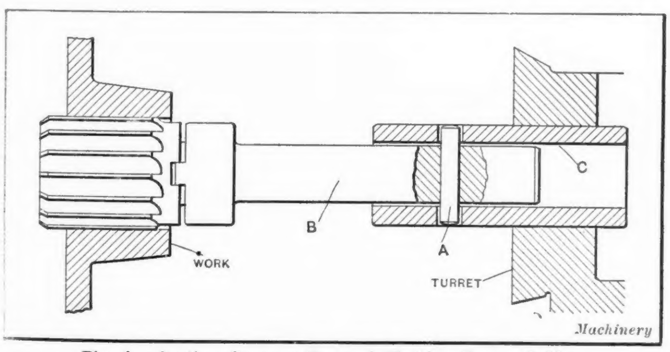


Fig. 2. Another Common Form of Floating Reamer-holder

Let us first consider the holder shown in Fig. 1—a very common type—consisting of the body A, the shank of which fits the turret hole, and a stem B having a "ball end" through which passes the driving pin C. This pin also serves to take the thrust of the cut. The forward end of the stem is tapered to permit the use of various sizes of shell reamers, such as the one shown at D. While this holder is probably more commonly used than any other type, its principal claim to efficiency is based on the floating action permitted by the ball end. Yet this ball, although it allows a swivel action, is also a disadvantage in that the reamer hangs so low that it must be very carefully started into the hole by hand. It also has a tendency to produce a slightly bell-mouthed hole, on account of the inevitable wabble when starting. If the ball end is made considerably smaller than the hole in the body (say 0.015 to 0.020 inch) it may be made to produce accurate results when properly handled. Adaptability and moderate cost are points in its favor.

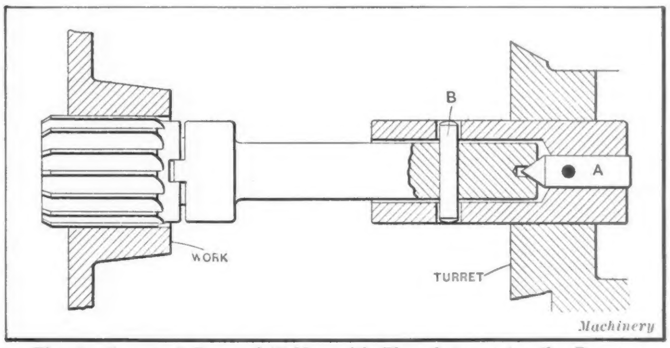


Fig. 3. Improved Form of Holder with Plug A to center the Reamer and take the Thrust

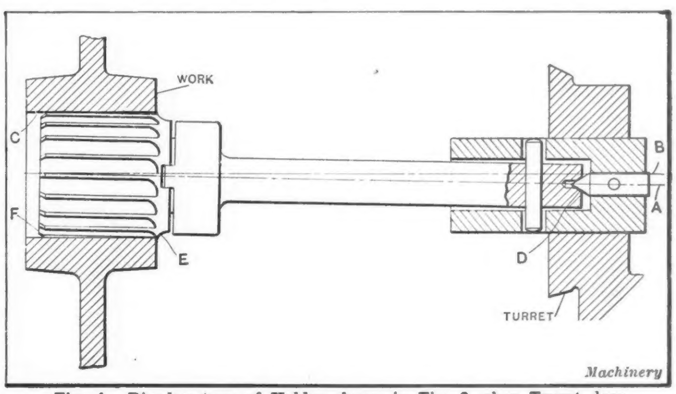


Fig. 4. Disadvantage of Holder shown in Fig. 3 when Turret does not index properly

Fig. 2 represents another very common type, in which the driving pin A is sometimes a free fit in the body and in other cases loose in the shank. This also is a holder which may be cheaply made, but it is subject to some of the same objections as the tool shown in Fig. 1. It is frequently made with too much clearance between the shank B and the hole C, this being as much as 1/16 inch in some cases. From 0.005 to 0.008 inch is much better, as the reamer will then enter the hole without assistance, and is less likely to cut large on its entrance.

An improved form of this holder is shown in Fig. 3, where it will be seen that a centering plug A has been added, which, in addition to centering the reamer, also takes the thrust. I believe that in certain cases the use of this plug is a disadvantage; for if the turret does not index properly, the plug must obviously be off center, thus producing a like condition in the reamer itself. Fig. 4 shows such a condition in an exaggerated form. The center of the turret hole A is 0.010 inch lower than the center of the spindle B, due to improper

*Address: 84 Washington Terrace, Bridgeport, Conn.

† Albert A. Dowd was born at North Granville, New York, 1872. He was educated in the New York University, Pratt Institute, and took an International Correspondence School course in bridge engineering. He has worked for the Atchison, Topeka & Santa Fe R. R. Co., Berlin Iron Bridge Co., Compound Motor Car Co., Columbia Motor Car Co., Pratt & Whitney Co., Stevens-Duryea Co., and Bullard Machine Tool Co. (with which latter concern he is still connected) having held the positions of timekeeper, machinist, toolmaker, lathe hand, experimental worker, chief tool designer, chief estimating department, specialist on turret tool work and machine design. Mr. Dowd's specialty is turret tool design of both vertical and horizontal machines.

upkeep, excessive wear on the ways, etc. The hole C has been generated by a single-point boring-tool and, therefore, should be symmetrical about the axis of rotation of the spindle. The reamer itself is 4 inches long and the distance from the forward end to the center of the plug D is 12 inches. There is a back taper to this reamer of 0.001 inch per inch; consequently it is 0.004 inch smaller at E than at the forward end, or

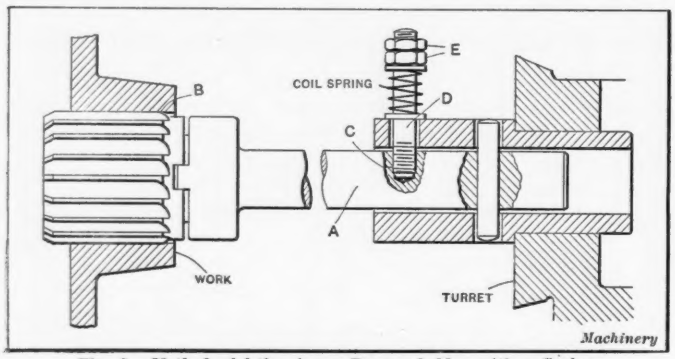


Fig. 5. Method of balancing a Reamer-holder with a Spring

0.002 inch on a side. The point E, then, will be 0.0013 inch lower than F, and theoretically will cut double this amount, *i. e.*, 0.0026 inch on the diameter.

Lest it be said that I have taken an almost impossible case

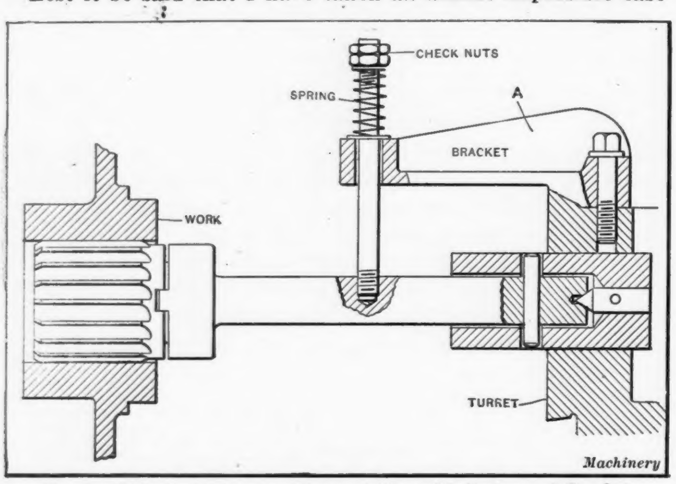


Fig. 6. Method of balancing Reamer-holder with Spring and Bracket from the Turret

as an example, I will say that about two years ago a condition even worse than this came under my observation. A turret lathe of a well known make had been in use on cast-iron work for only about six months and yet the center of the turret hole was 0.014 inch lower than the center of the spindle, and we were unable to produce a correctly sized hole upon it until the spindle bearings had been scraped to correct alignment with the turret. After this had been done, no further trouble was experienced.

An instance of a method of support by means of a spring is shown in Fig. 5, the holder being of the same general type as the one shown in Fig. 2. The reamer in this case was 3½ inches in diameter and the shank A rather long. In testing the equipment preparatory to shipment, it was found impossible to obtain a correctly sized hole at the end B, where the reamer began to cut. It was bell-mouthed to the extent of 0.003 to 0.005 inch, for about half an inch back, and the entire hole was inclined to be over size. The weight of the reamer being considerable and the shank rather long, caused a "drag" in entering the hole. The shank was drilled and tapped at C for a ½-inch stud, and a ⅝-inch clearance hole was provided in the holder directly above it at D, a stiff coil spring being placed in position as shown. The check-nuts E were then used to compress the spring until the weight of the reamer was properly balanced. This arrangement was found to correct the trouble and the hole obtained was sized properly. Fig. 6 represents a similar case where the reamer was still longer and heavier, but in this instance the supporting bracket A was fastened to the turret itself, instead of taking the thrust of the springs directly on the holder.

The holder shown in Fig. 8 was made for a very heavy piloted taper reamer of the dimensions indicated in the illustration. The cross-slide was used during the setting of the work, and it was necessary to provide a long shank for the reamer in order to avoid interference. This increased the weight to somewhat over 40 pounds, and it will be readily seen that some sort of support for the shank was essential to prevent a dragging action in the hole. For this purpose three spring shoes were provided, 120 degrees apart (one of which is shown at A). The pressure on the shoes was controlled by

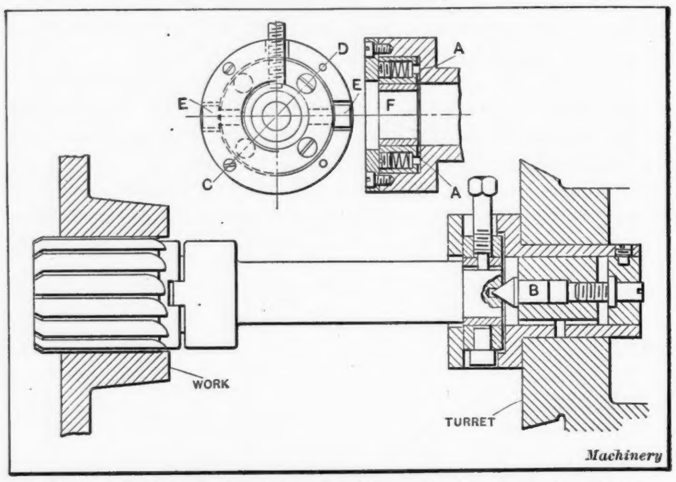


Fig. 7. Pratt & Whitney Reamer-holder equipped with Spring Shoes and Center Support

the backing-up screws which assisted in keeping the shank in a central position. The thrust of the cut was taken by the screw B, and the driver C (a detail of which is shown in the upper portion of the drawing) took care of the torsional strain. The clearance hole in the cover plate D was only 0.004 inch larger than the shank E, thus permitting the end of the pilot to enter the bushing F without assistance. Had this clearance hole not been made in this way, it would have been a difficult matter to start the pilot properly, because of the weight which would have had to be lifted and started by hand. This holder gave very satisfactory results.

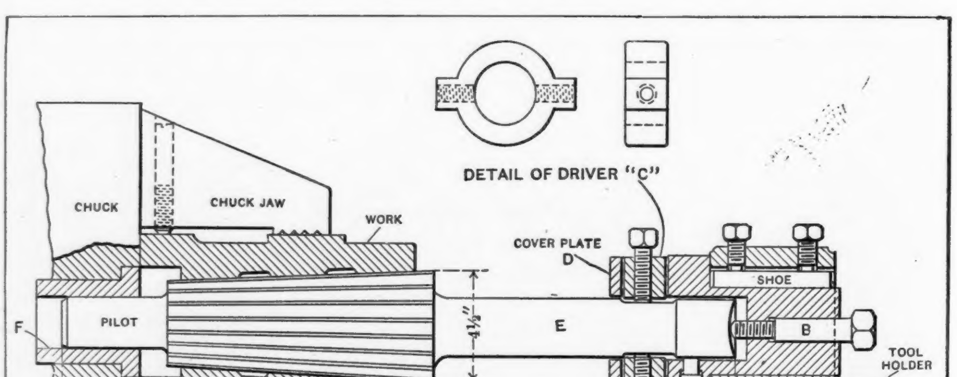


Fig. 8. Large Taper Reamer and Method of balancing it

The Pratt & Whitney Co., Hartford, Conn., manufactures a holder of a somewhat similar construction (see Fig. 7) in which equalizing spring shoes are also employed, as shown in the upper portion of the illustration at A, the section being

taken along the line C–D. An adjustable and renewable center support B is an additional refinement. The bushing F may be easily made to fit various sized shanks. The drive provided through the pins E is exceptionally powerful.

Fig. 9 represents a type of holder suitable for small reamers, which may be so designed that standard tools of this kind and

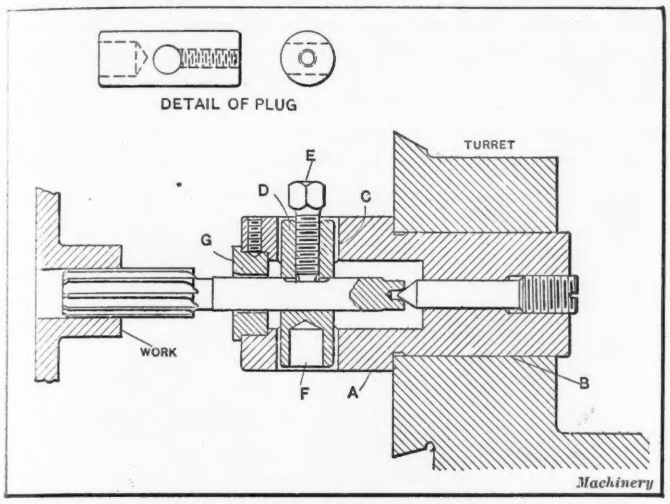


Fig. 9. Reamer-holder adapted for Use on Small Hand Screw Machines

of various sizes may be easily used. The body A is made from square stock of suitable size turned down at B to a diameter corresponding with the hole in the turret. A piece of cold-rolled steel D is drilled and reamed to receive the reamer shank, and a set-screw provided at E to hold it in place. The drilled hole at F is for the purpose of removing unnecessary weight from the plug. It is obviously an easy matter to make up a set of plugs for different sizes of shanks and a series of

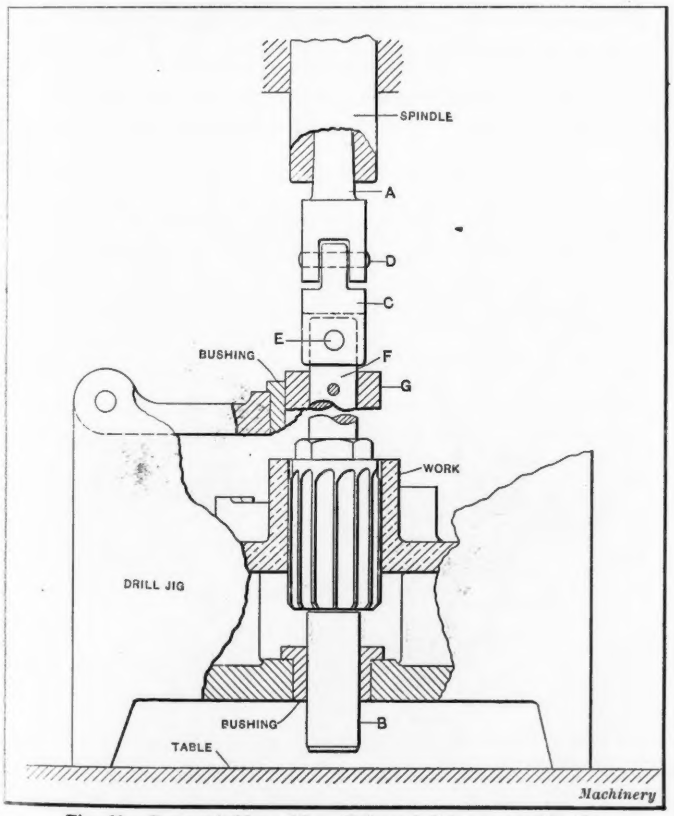


Fig. 10. Reamer-holder with a Universal Joint to provide the Floating Feature

bushings G to correspond. These bushings control the amount of float in the reamer, and, speaking generally, from 0.003 to 0.005 inch should be sufficient clearance between the bushing hole and the reamer shank. This type of holder is extremely useful on hand screw machines, and although it possesses a centering plug, it is less likely to cause inaccuracy, as its use is confined to the smaller machines where there is less wear and tear and consequently less chance for variations in alignment.

Fig. 12 shows an entirely different type of holder which operates under quite different conditions. It is used on the Bullard vertical turret lathe when the swivel slide carrying the turret has been set over at an angle for the purpose of boring the taper hole A in the automobile flywheel shown in the illustration. The reamer hangs vertically from the removable pin B, which is free to float in the slotted shank C. This shank fits the turret hole and is prevented from twisting by the pin D. Obviously the position of the turret "observation stops" must be determined with some care, in order that the reamed hole may be of the correct angle and not distorted by crowding over and thus "cocking" the reamer. The correct position may be easily determined by setting the reamer snugly in place in a correctly sized hole, and then bringing

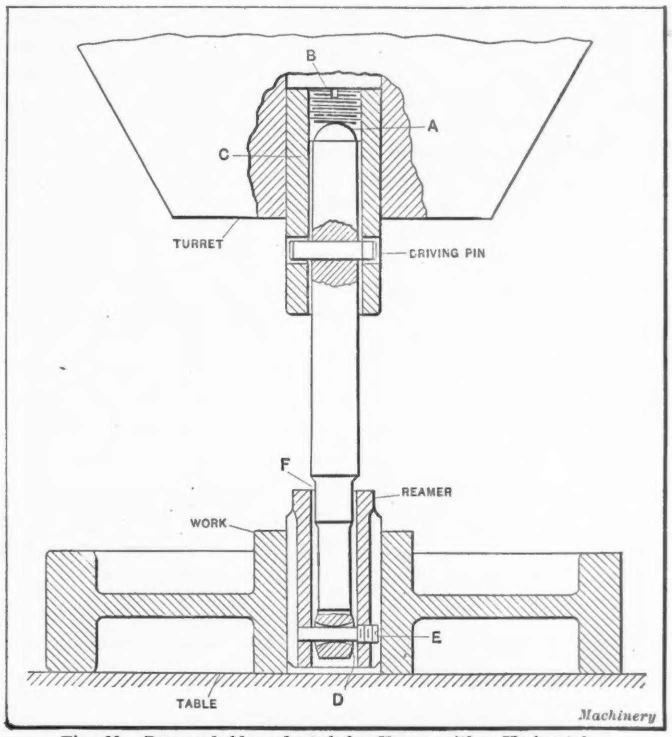


Fig. 11. Reamer-holder adapted for Use on either Horizontal or Vertical Machines

the turret down until the pin B passes freely into its proper place. The necessary stops are then set for this location.

Another type of holder which is used in either a "vertical turret lathe" or in a horizontal machine is shown in Fig. 11. It has a ball-end shank A thrusting against the backing-up

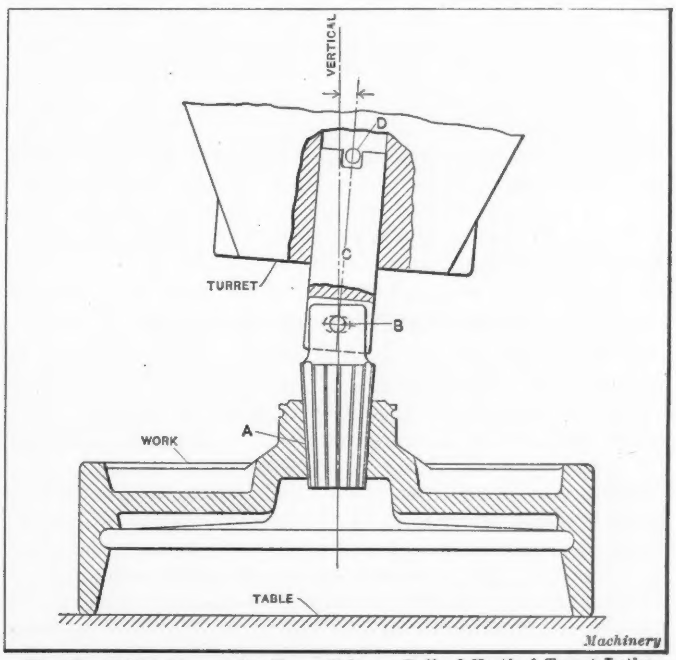


Fig. 12. Holder for reaming Taper Holes on Bullard Vertical Turret Lathe

screw B in the end of the holder C, through which the driving pin passes. The forward end of the shank A is also ball-ended at D, and the screw-pin E passes through this portion, thus securing the reamer in position. It will be noted that the hole in the shank, through which this pin drives the tool, is bell-mouthed on each side of the center, and that there is also

clearance at *F* between the shank and the reamer shell. This holder gives a free floating action in any direction, and comes nearer to the ideal type than any of those previously mentioned. It was manufactured at one time by the Bullard Machine Tool Co., Bridgeport, Conn.

Fig. 10 represents a holder having a universal joint, which I have seen used in a drill jig of the type shown in the illustration. The shank *A* is made to a standard taper corresponding to that of the drill press spindle, and the piloted end *B* is guided by the bushing in the jig. One end of the intermediate link *C* is milled flat and is hung loosely on the pin *D* through the slotted shank. The other end of this link is slotted at right angles to the first-mentioned flat and serves to drive the reamer through the connecting pin *E*, which passes through its shank *F*. A hardened and ground collar *G* is also pinned to the shank and is guided by the upper bushing in the jig. Various adaptations of this universal joint are seen in connection with fixtures used on horizontal boring machines, and are often made with some device for rapidly interchanging bars, reamers, etc., in place of the pin *E*.

There is another holder (see Fig. 13) which is sometimes erroneously referred to as a "floating holder," but it has no "float" whatever, although it does have both vertical and horizontal adjustment. It is extremely useful in automatic screw machine work. The adjustable cap *D* may be quickly set to correct any inaccuracies of alignment between the turret and spindle by loosening the two screws *B*. The holes in the cap are made 1/16 inch over size to allow for this, and the bushing *A* is fitted to the reamer shank. The body *C* of the holder

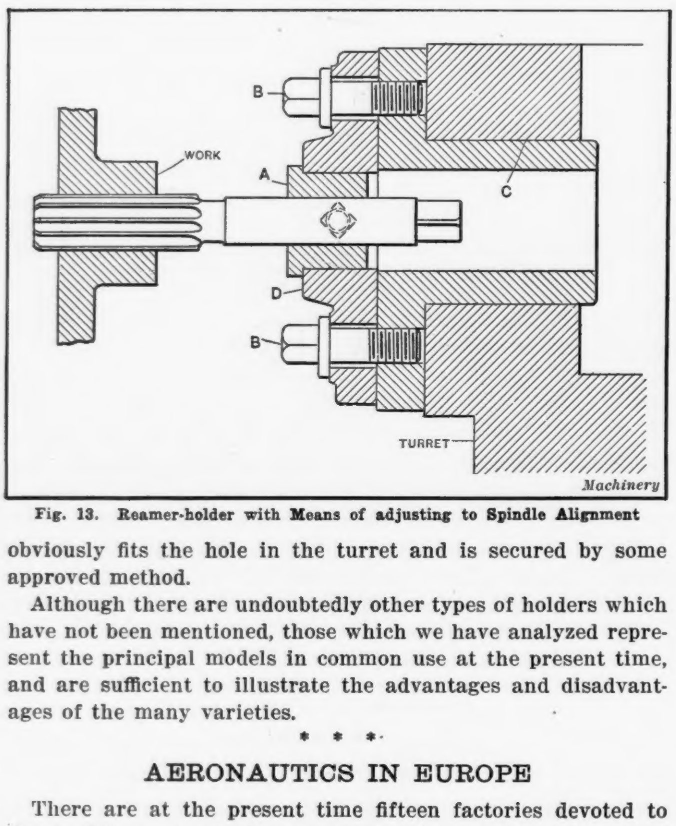


Fig. 13. Reamer-holder with Means of adjusting to Spindle Alignment

obviously fits the hole in the turret and is secured by some approved method.

Although there are undoubtedly other types of holders which have not been mentioned, those which we have analyzed represent the principal models in common use at the present time, and are sufficient to illustrate the advantages and disadvantages of the many varieties.

* * *

AERONAUTICS IN EUROPE

There are at the present time fifteen factories devoted to the building of aeroplanes and airships in Germany, about twenty in France, six in England and five in Austria. It is stated that there is an over-production of aeroplanes and that the industry is suffering from slackness of business. The interest in flying meets seems to be decreasing. An attempt is being made in Germany to arouse greater interest in aviation and better organization of meets. The Government has appropriated $60,000 for the establishment of an experimental station for aerial navigation at Berlin. Twelve individual manufacturers of automobile and aeroplane motors have affiliated themselves with the station and contribute yearly an amount of about $16,000. The first task of the new institution will be to judge the motors submitted in the contest for the Kaiser's $12,000 prize for the best German made aeroplane motor.

* * *

It is sometimes a good plan to listen to what the other fellow has to say before you begin to talk.

THE COMMON LIMITATION OF MACHINE TOOL CHANNEL ROOM FOR CHIPS

BY CHARLES E. SMART*

With the use of high-speed steel cutters and high-speed drills, and a cooling compound, the necessary channel room for chips on milling machines and drill presses for machining steel evidently has not been given the serious study by the designers of these machine tools that it should receive. Take, for instance, one of the latest milling machines on the market, which very easily can remove eighty cubic inches of metal a day, or about twenty-five pounds of dry chips, yet the channel room on the machine has not the capacity to allow more than

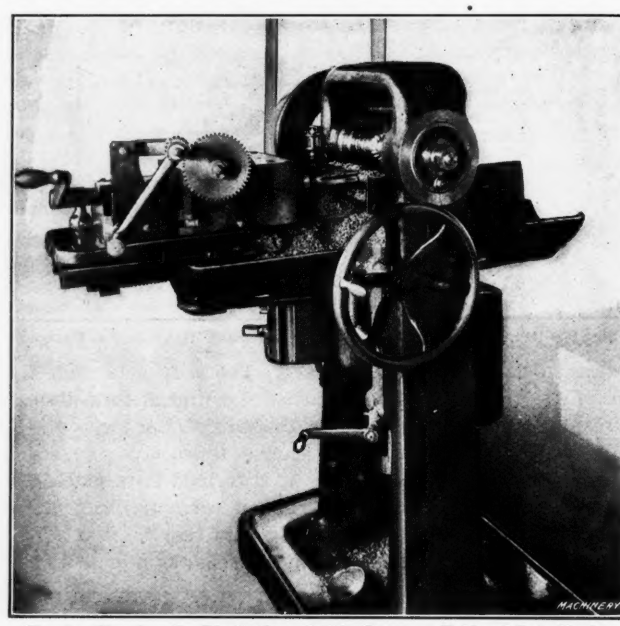


Fig. 1. Showing the Limitation of Chip Room on Table of Late Design of Manufacturing Milling Machine

two pounds of chips to gather before the cooling compound is beginning to drip from the ways of the machine onto the floor. See Fig. 1.

To sufficiently cool the high-speed cutters at the speed and feed at which they are driven, about a quart of cooling compound is required per minute to each cutter; so unless the channel room is kept fairly free, serious interruptions to the

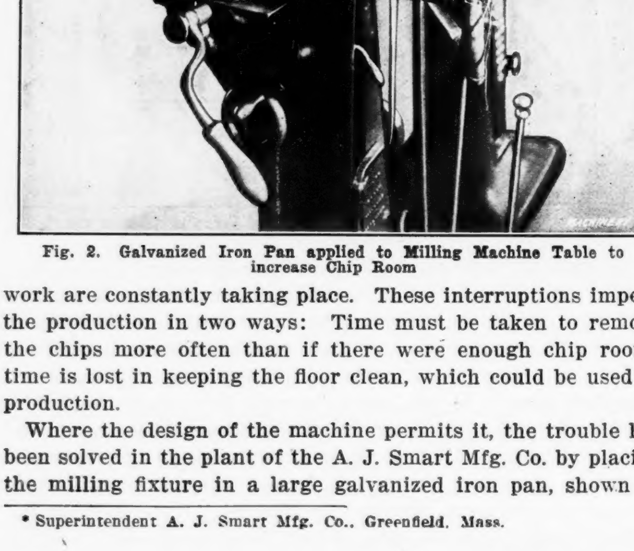


Fig. 2. Galvanized Iron Pan applied to Milling Machine Table to increase Chip Room

work are constantly taking place. These interruptions impede the production in two ways: Time must be taken to remove the chips more often than if there were enough chip room; time is lost in keeping the floor clean, which could be used in production.

Where the design of the machine permits it, the trouble has been solved in the plant of the A. J. Smart Mfg. Co. by placing the milling fixture in a large galvanized iron pan, shown in

* Superintendent A. J. Smart Mfg. Co., Greenfield, Mass.

Fig. 2, but the majority of milling machines on the market are so designed that no provision of this kind is possible.

A width of three inches and a depth of three inches (or the equivalent, nine square inches) where the machine will allow it, around the outside of the milling fixture on milling machines, is none too much, yet so far as the writer knows there is no milling machine on the market to-day that comes up to this requirement. With these channels, scoops of special design can be made to fit the channels so that it would not be necessary to remove the chips more than once in four hours or perhaps five hours.

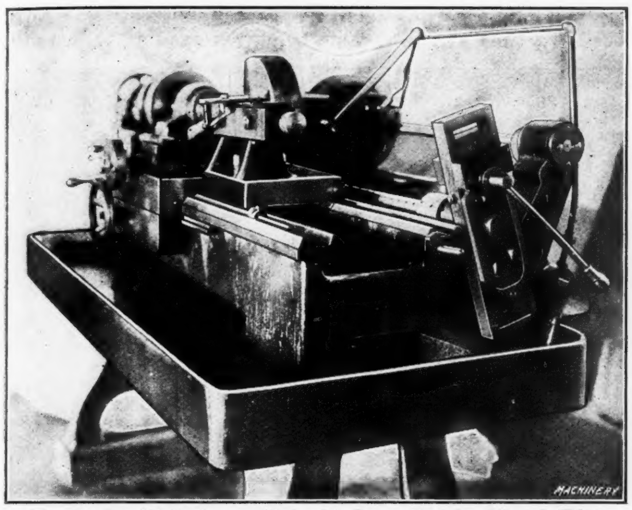


Fig. 3. Special Lathe provided with Large Pan for Oil and Chips

On the special lathe shown in the illustration Fig. 3, the chip room was one of the first points considered after the general design of the machine was settled upon, and it will be noticed that practically the whole machine is enclosed in a cast-iron pan. The only reason that the back of the bed does not show complete enclosure is that the largest planer available for planing the bed was not wide enough to allow the maximum width desired.

The amount of chips produced daily is a considerable item on jig work on the high-speed drilling machine shown in Fig. 4, and the galvanized iron backing was necessary to keep the chips from being brushed on the floor. Unfortunately, the drill press shown had been thoroughly cleaned before the photograph was taken, but the channel room on the bed will not appeal to any one as being at all sufficient. It will be noticed that there are three outlets into the reservoir underneath the table in order that the cooling liquid may escape freely.

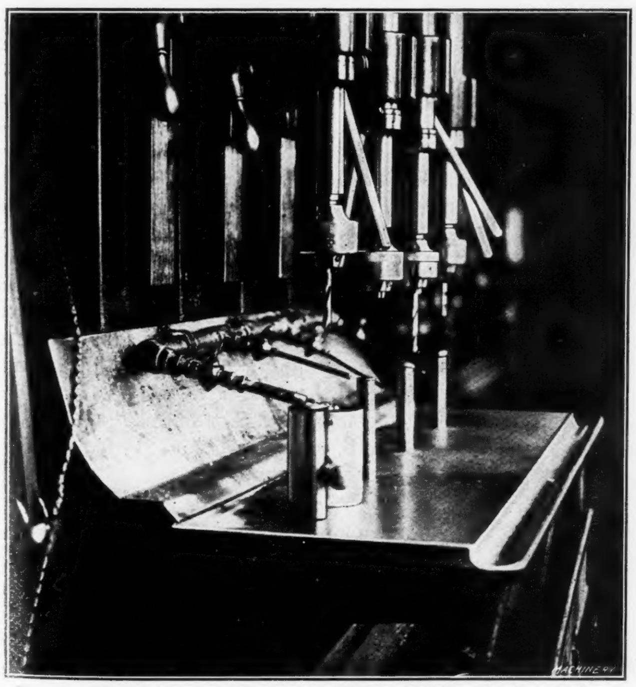


Fig. 4. Illustration of High-speed Drilling Machine showing Lack of Chip Room in Table Channels

SETTING DIAMONDS

Setting diamonds is one of the troublesome jobs that fall to the lot of a machinist or grinder at more or less frequent intervals. The method in general use consists of drilling a hole for the diamond, and after placing it within the hole, closing the metal in about the stone as far as possible, and then pouring molten spelter to fix the diamond in place. The chief objection to this method is that the spelter will not flow evenly around and beneath the stone; consequently the stone is not supported at all points, and quickly works loose.

The following method of setting diamonds has been found to be superior to the method just described: First drill the hole for the diamond to the usual depth, a little deeper than the greatest dimension of the stone. The drilling should be done without lubricant, as oil of any kind tends to prevent the spelter from flowing smoothly. This being done, the hole should be closed in slightly—just enough to make it out of round. The spelter is now poured into the hole, filling it completely, and the diamond, held in a pair of tweezers, is pushed into the liquid spelter in the hole until it strikes the bottom. In doing this, an amount of spelter equal to the displacement of the diamond is pushed out of the hole, and when this drop of spelter makes its appearance it is certain that there are no vacant spots under the stone. After the spelter has cooled, the end of the rod in which the diamond is located can be shaped up in the customary manner. The fact that the hole is slightly out of round prevents the core of spelter from working out of the end of the rod. C. L. L.

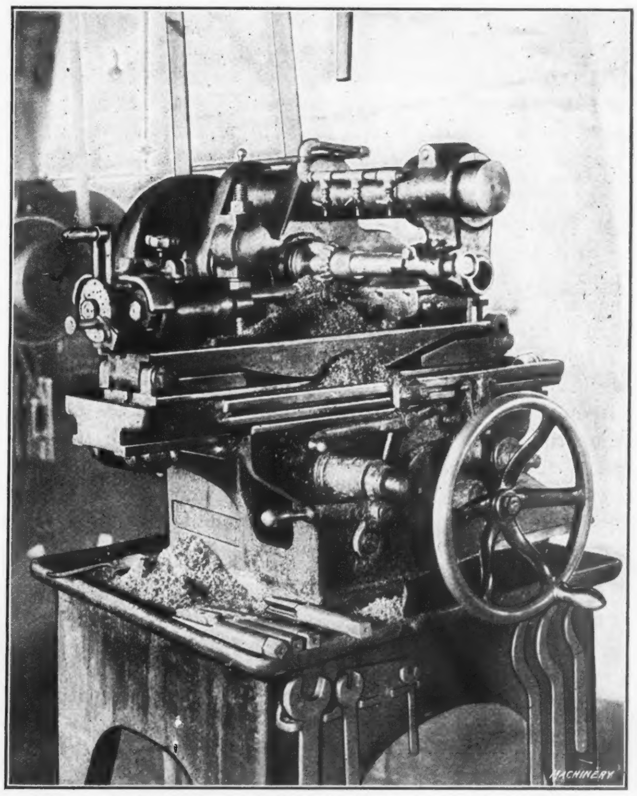


Fig. 5. Typical View of Milling Machine used in Manufacturing, showing Lack of Chip Room on Table

* * *

Some users of motor trucks who have conducted careful comparative tests of solid and pneumatic tires under heavy loads, have arrived at the conclusion that pneumatic tires within certain limits of capacity are the more efficient, considering speed, power consumption, durability of tires and general wear and tear. But in order to realize satisfactory service, pneumatic tires must be provided of a size and strength proportionate to the load. This means tires of great size and heavy cost for large trucks if they are to prove satisfactory. An under-tired truck will cause only trouble and expense. Tire makers are ready to furnish eight by thirty-eight inch pneumatic tires which carry a normal air pressure of 160 pounds per square inch. A tire of this size will support a static load of 4000 pounds with a deflection of less than one-half inch, and is rated at 2000 to 2200 pounds capacity.

MAKING A SHEET-STEEL MITER-BOX IN THE PUNCH PRESS

SOME INTERESTING PUNCHES AND DIES USED IN PRODUCING MITER-BOXES FROM SIXTEEN-GAGE SHEET STEEL

BY DOUGLAS T. HAMILTON*

Some excellent examples of die work obtained in the factory of the H. C. Marsh Co., Rockford, Ill., manufacturer of picture frame tools and miter-boxes, are shown in the accompanying illustrations. These views illustrate some of the most interesting punch press operations on the "Marsh-Ayer" pressed-steel miter-box, which is shown assembled and ready for use in Fig. 1. Every part of this miter-box, with the exception of the posts and an arch shaped forging beneath the table, are made from 16 gage (0.0625 inch thick) 20 point carbon sheet steel, which is known as a fine grade of deep drawing steel.

Not only does the production of this miter-box from sheet steel require the use of intricate dies and tools, but it also demands the aid of a punch press capable of producing the parts on a manufacturing basis. Although the idea is still held by many that the punch press is only suitable for light sheet-metal work, and is not capable of heavy sheet-steel forming, nevertheless, wonderful strides have been made in the past few years in the design of punch presses adaptable to the manufacture of many parts from heavy sheet steel. The production of this miter-box from sheet steel 0.0625 inch thick in a punch press of the type shown in Fig. 3, should be conclusive proof that the punch press of present-day design can be classed as a manufacturing machine.

Press Operations on the Miter-box Frame

The frame of the miter-box, some of the press operations on which are illustrated in Fig. 2, is the most difficult part to produce, and is the one that requires the greatest amount of power. The frame is first cut to blank form, as shown at *A*, and is then drawn up into box form. In its finished shape, it is 18⅝ inches long by 4½ inches wide and 1¼ inch deep (this latter dimension is the finished height, from 1/16 to ⅛ inch being allowed for milling). This difficult drawing operation on the frame, as well as all the operations on the other parts of the miter-box, is accomplished in a No. 4 Rockford geared punch press, shown in Fig. 3, which is operated at 45 revolutions per minute, and at this speed is capable of exerting a pressure of 60 tons per square inch.

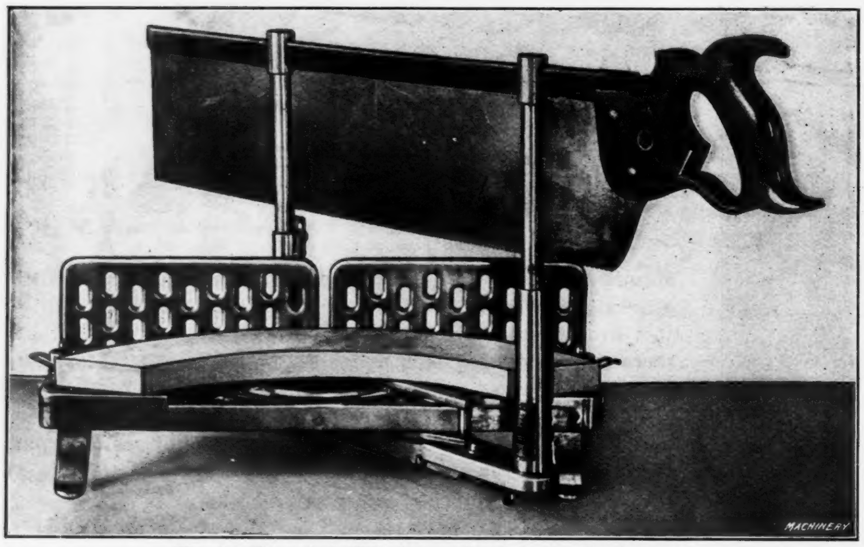


Fig. 1. Sheet-steel Miter-box produced in the Punch Press

The blank for the miter-box frame, which is shown at *A* in Fig. 2, is much longer than the bed of the punch press, so that a special bolster has to be provided, and in this is inserted a pan for catching the blanks as they are cut out. The pan is made deep enough to hold three blanks, and is removed from under the die when this number is cut out. There are, in all, fourteen punch press operations required to produce the frame of the miter-box. Briefly, they are as follows: Blanking (see *A*, Fig. 2); center drawing; embossing (see *B*, Fig. 2); graduating; stamping figures; drawing up into box shape (see *C*, Fig. 2 and also Fig. 3, which shows the operation being performed); center perforating (see *D*, Fig. 2); center drawing; perforating, two operations. Only one-half of the frame is perforated at a time, the same punch and die being used for each end, and the frame being reversed end for end. After perforating the holes in the two end portions of the frame, they are drawn up, one-half the number of holes being drawn at a time and the frame being reversed as before mentioned. The type of drawing die used is similar in construction to that shown in Fig. 7. The final operation is the embossing of the two ends; this requires two operations in the same die, one end being done at a time.

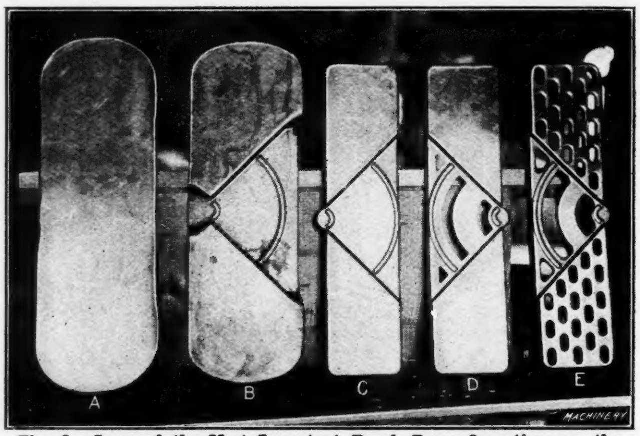


Fig. 2. Some of the Most Important Punch Press Operations on the Frame of the Sheet-steel Miter-box shown in Fig. 1

Graduating and Stamping the Frame

After the center portion of the frame has been drawn up and embossed so that it is in the condition shown at *B* in Fig. 2 (which operations are performed with tools of comparatively simple construction), the next operation is to graduate the center portion. The graduations are made on an arc of a circle, so that any angular movement of the saw guide can be obtained in degrees for any setting within an angle of 90 degrees. These graduations are stamped in the frame in the punch press shown in Fig. 3, by a die which has V-projections of the required length formed on its top face. The other member of the die (or punch) is perfectly smooth, and is only used for pressing the graduations into the frame. The tool used for stamping the figures is shaped somewhat like a regular punch-holder, and is held in the ram of the press. This holder carries, or has inserted in it, the required number of stamps which are of a similar type to those used when stamping by hand, and are held in place in the holder by set-screws. The lower member of this stamping tool is also left smooth, and is provided with guides to locate the work properly.

Drawing up the Sides of the Frame

The drawing up of the sides of the frame is a difficult operation because of its irregular shape, its size, and the height to which the sides are drawn. Fig. 3 shows the tools used for drawing up the sides of the frame set up in a No. 4 Rockford geared press, and gives some idea of the enormous power required for this operation. As can be seen, the die projects a considerable distance past the frame of the press. The drawing die *A* is held on a special bolster *B*, which is bolted to the bed of the press. The work after being drawn is ejected from the lower die by a spring pad which bottoms in a recess in the die shoe, when forced down by the work and upper member of the die, or punch.

The drawing punch is fastened to a large punch-holder *D*, which is held to the ram of the punch press and is provided with two protecting arms, not shown. These arms act as

*Associate Editor of MACHINERY.

stops for the heavy springs *C* which furnish pressure to the pressure pad *E*, the function of which is to prevent the stock from wrinkling while the deep vertical flange around the edges of the frame is being drawn. It will be noticed that the pressure pad is cut away on its lower face to clear the embossed center portion of the frame, which has been accomplished in a previous operation. The drawing punch is also cut away in a similar manner. The accomplishment of this difficult operation in a press of this size speaks favorably for the high-duty punch presses built by the Rockford Iron Works, Rockford, Ill., and demonstrates in a remarkable manner the manufacturing capabilities of these machines.

Drawing up the Edges of the Perforations in the Frame

After the sides of the frame have been drawn up, the center portion is perforated in several places as shown at *D* in Fig. 2. Then the edges of these perforations are drawn up about 1/4 inch to increase the strength of the frame. This operation is accomplished with the tools shown in Fig. 4. Here *A* is the punch-holder which is held to the bolster of the punch press in the usual manner, and is provided with hardened and

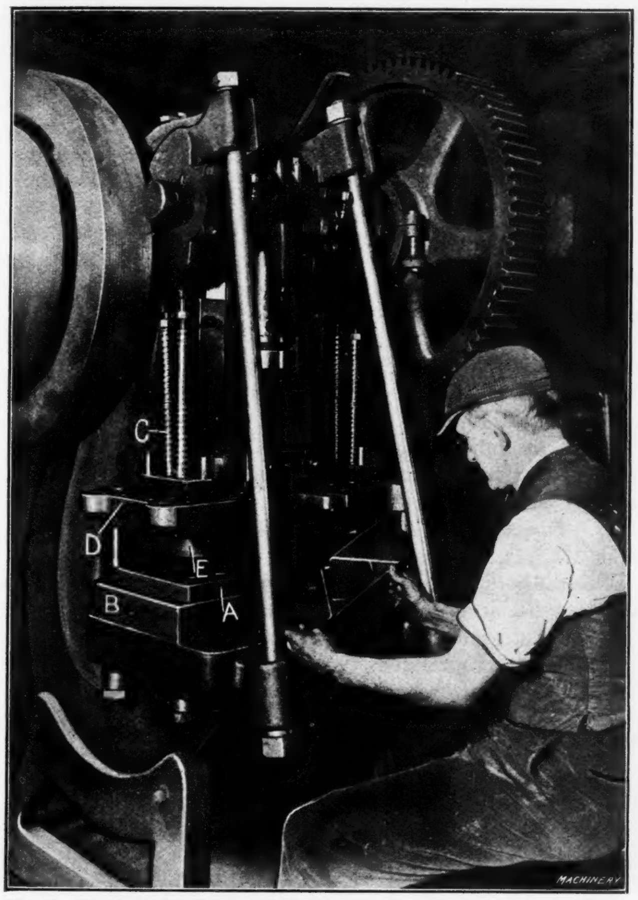


Fig. 3. No. 4 Rockford Geared Punch Press used in producing the Sheet-steel Miter-box shown in Fig. 1, set-up for drawing up the Sides of the Frame

ground pilot pins *a* which locate and guide the drawing die *B*. The drawing punches *b*, which are fastened by screws to the punch-holder *A*, are surrounded by a floating pad *c*, the function of which is to keep the top surface of the stock perfectly flat while the edges of the perforations are being drawn. The drawing punches *b* are, of course, made smaller than the irregular shaped holes in the drawing die to allow for the thickness of the metal. The holder carrying the drawing die *d* is fastened to the ram of the press by the shank, which is not shown in the illustration.

In operation, the frame is laid on the punch *A* and is located by depressions in the floating pad *c* which fit the embossed center portions of the frame. As the press is operated, the die *d* descends and as soon as it touches the blank it holds the latter firmly against the floating pad which prevents the work from bending while the punches are forcing the edges of the perforations into the die impressions. These tools, when made, were intended to draw up the edges of oblong-shaped holes to be cut in the arch shaped strip *e* (see finished frame resting on top of tools), but were discarded when it was found that the frame was rigid enough without this additional drawing operation. The completed frame is shown at *E* in Fig. 2.

Making Miter-box Legs

The legs for the miter-box shown in Fig. 1 are also made from 0.0625 inch, 20 point carbon deep-drawing sheet steel, and are completed in three operations in the punch press. The first operation, shown at *A* in Fig. 6, consists in cutting out a blank of the required shape; this operation is accomplished with a simple blanking punch and die. The next operation, shown at *B*, is the first drawing operation and consists in turning up the two sides of the blank. The work when being drawn is not forced through the die, but is ejected

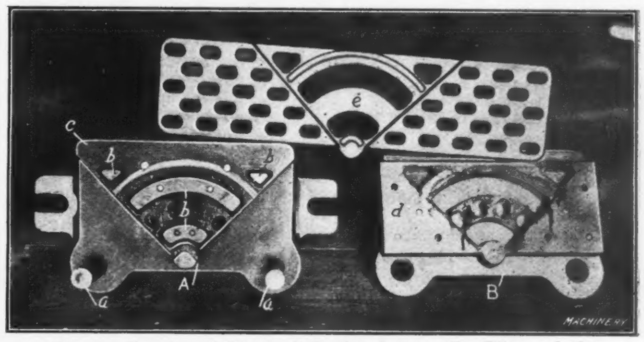


Fig. 4. Punch and Die used in drawing up the Edges of the Perforations in the Center of the Miter-box Frame

by means of a spring pad inserted in the die and bottoming in a recess in the die shoe, when the ram is at the lowest point of its stroke.

The next operation on the miter-box legs, which is the most interesting, consists of the final drawing to shape. The result of this operation is shown at *C* in Fig. 6, and also at *b* in Fig. 5, where the tools used are also shown. The conditions met with in the production of this piece are unusual, in that the depth of the draw is 2 11/16 inches, and the height of the blank 11/16 inch, making a total of 3 3/8 inches, whereas the stroke of the punch press used is only 3 1/2 inches. It is evident, therefore, that there is a clearance of only 1/8 inch between the punch and the blank when the ram of the punch press is at the highest point of its stroke. This, added to the irregular shape of the work, made it extremely difficult to remove the finish-formed leg from the die. It was only possible to do so by cutting away the front wall *c* of the die, shown at *A* in Fig. 5, and by using a cam-operated stripper *d* to pull the work from the punch *e*. A knock-out was added for this pur-

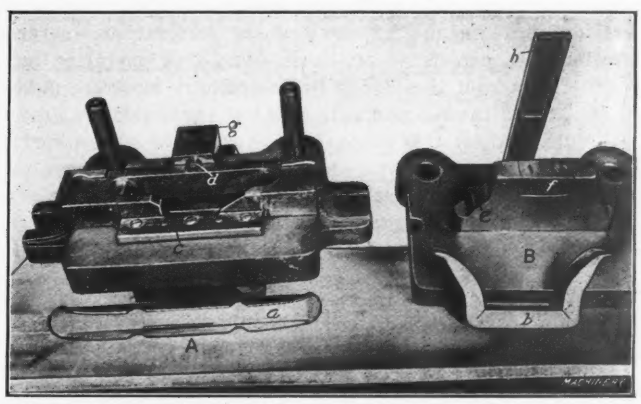


Fig. 5. Punch and Die used for performing Final Drawing Operation on Legs of Miter-box shown in Fig. 1

pose, but as it projected below the 1/8-inch allowable clearance, when the ram of the punch press was at the extreme height of its stroke, it had to be abandoned. The block *f* which is set into the punch shows the position of this knock-out as originally used.

Referring to the drawing die used for the leg, which is shown at *A* in Fig. 5, it will be noticed that the lower face of the die block projects past the lower face of the bolster. This was found necessary to give sufficient clearance for getting the blank into and out of the die, as it is evident that thickening the bolster sufficiently to give the required depth would have raised it too much above the top surface of the bed of the punch press. The stripper *d*, which consists of a flattened

plunger held inward by a coil spring located in the block *g*, is operated by the strip *h* attached to the punch-holder *B*. The blank shown at *a* is located in the correct relation to the punch and die when being drawn, by a milled impression on the top face of the die bolster.

Punch and Die for Drawing up Edges of Perforations in Rear Guide Plates for Miter-box

The back of the miter-box, as shown in Fig. 1, consists of two perforated and embossed plates, which are also made from 1/16-inch sheet steel in the punch press. The punch and die used in drawing up the edges of the perforations in these plates are shown at *A* and *B* in Fig. 7, a completed rear guide being shown at *C*. Before these plates are ready for the final

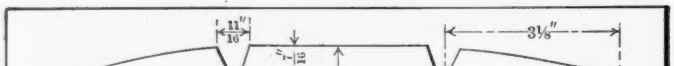


Fig. 6. Illustration showing Sequence of Punch Press Operations on Miter-box Legs

operation—drawing up the edges of the perforations—several operations are performed on them. The first operation consists in cutting out the blanks in an ordinary blanking punch and die. Then the top and side edges of the blank are drawn up, the die used for this purpose being provided with a spring pad for ejecting the work, which is not forced through the die. Following this operation, the holes are pierced, thus preparing the blank for the final operation.

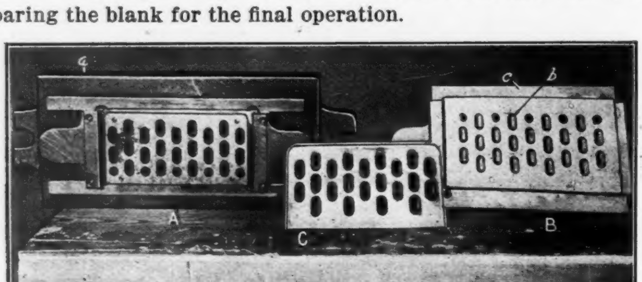


Fig. 7. Punch and Die for drawing up Edges of Perforations in Rear Guide Plates

The drawing die used in drawing up the edges of the perforated holes, as shown at *A* in Fig. 7, also acts as a guide for the blank, locating the latter from the turned up edges. The punches *b*, as was the case with those shown in Fig. 4, are surrounded by a floating pressure pad *c* which keeps the blank straight when the edges of the perforations are being drawn and also assists in stripping the work from the punches. All the perforations in the various members of the miter-box are drawn up to a height of about ¼ inch from the opposite face of the blank. The object in making these "embossed" perforations, of course, is to strengthen the frame and thus permit it to be made from comparatively thin material. Those familiar with this class of work know that embossing and perforating the material in the manner shown makes it very stiff in comparison with flat plates of the same material. The appearance is also greatly improved by the addition of these apparently expensive operations. On the other hand, while it is possible to carry on these operations successfully in the punch press, it would be difficult to produce a miter-box from material of sufficient thickness to give the same strength, if the embossing operations were not performed.

* * *

DETERMINING GEOMETRICAL PROGRESSIONS WITH A SLIDE RULE

A recent issue of *Page's Weekly* gave the following method of working out geometrical progressions within specified limits. No tables of any kind are required, all that is necessary being a slide rule which is used in conjunction with a piece of paper. The method is limited to progressions which come between the range of 1 to 100, 10 to 1000 and so on with the slide rule closed up. With the slide rule fully extended ranges of from 1 to 10,000 etc., can be handled. The method is based on the fact that the slide rule is divided logarithmically, that is the distances of all numbers from the left-hand index are proportional to the logarithms of the numbers; therefore, all numbers of a series in geometrical progression are an equal distance apart.

The following examples will serve to make the method clear. Suppose it is required to figure out a geometrical progression of 9 terms, the first term being 30 and the last term 320. A stiff piece of paper having a straight edge is laid on the slide rule and marks made on it opposite the 30 and 320 graduations. With a pair of dividers, this distance is divided into eight equal spaces. The points of division between these spaces are marked on the edge of the paper and the latter is then placed on the slide rule between the 30 and 320 graduations. The numbers of the geometrical progression will then be read off opposite the division points which were marked off on the paper. The following solution will be obtained: 30, 40.3, 54.2, 73, 98, 132, 177, 238.5 and 320. These results will be found very close to the solution of the problem obtained by logarithms, and they are quite accurate enough for practical purposes.

The second problem will explain the method of determining a geometrical progression, the limits of which lie between 1 and 10,000. For this purpose, suppose it is required to determine a geometrical progression of 16 terms between the limits of 6 and 310. In this case, the range cannot be covered on the *A* scale of the slide rule, as starting from 6 on the left-hand of the scale brings one up at the 100 graduation at the right-hand end. To get the necessary range, place the left-hand index of the *B* scale opposite the right-hand index of the *A* scale. The limits of the progression then lie between 6 on the left-hand half of the *A* scale and 310 on the left-hand half of the *B* scale. Proceeding in the manner previously described, lay the edge of a sheet of paper on the rule and place a mark opposite the two limits, *i. e.*, 6 and 310. Then divide the distance into 15 parts (the number of terms in the progression minus 1). The paper is then laid on the slide rule and the numbers of the progression read off opposite the division points which have been produced in this way. If this problem is tried, the following results will be obtained: 6, 7.8, 10.2, 13.2, 17.2, 22.3, 29, 37.8, 49.2, 63.8, 83.2, 108, 141, 183, 238 and 310. When a progression of this kind is to be determined for some purpose of design, it is not usually necessary to obtain absolutely accurate results, and the preceding method will be found quite close enough.

* * *

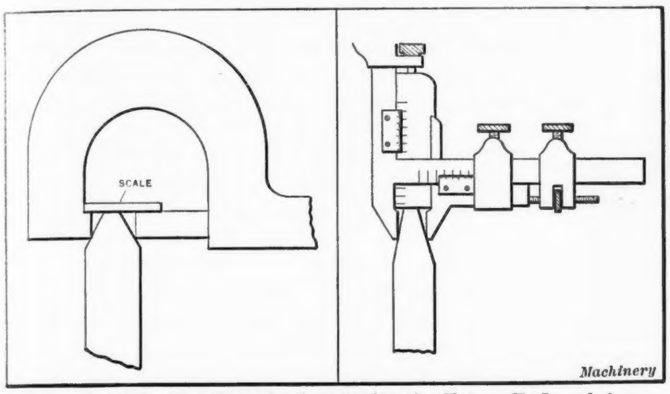
The *London Daily Mail* has offered $50,000 for the first aeroplane flight across the Atlantic Ocean in either direction in seventy-two hours' time. The flight must be made between some point in the United Kingdom and some point in the United States, Canada or Newfoundland. The competition is international and is open to all aviators throughout the world. It is permissible to alight on the water and to take on more fuel if arrangements for this can be made.

MEASURING THE FLAT ON U. S. AND ACME THREAD TOOLS

BY GUY H. GARDNER*

The gages sold in the tool stores can be used for measuring the flat on U. S. and Acme thread tools if they happen to have a notch of the required pitch, but it is often necessary to measure a flat for which such gages make no provision. This is especially the case with Acme tools.

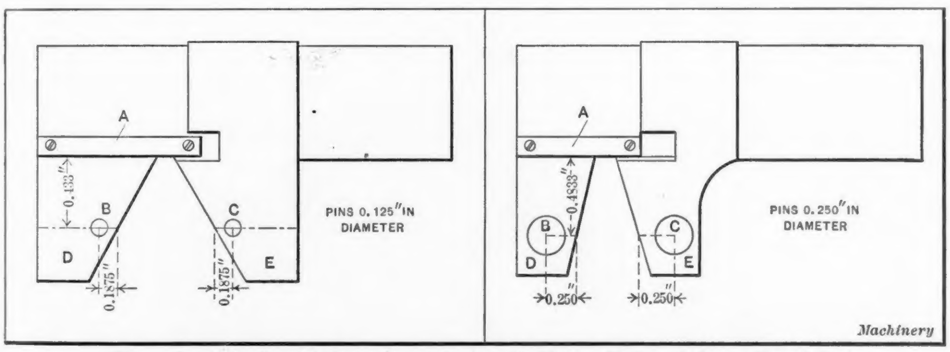
Fig. 1 shows a method of making such measurements, which gives a close approximation of the actual value. It is based on the fact that the spindle of a micrometer is of known diameter. Referring to the illustration, it will be seen that a scale or parallel is laid on the spindle and the micrometer anvil, the tool being placed with its flat resting against the scale. The micrometer is then closed to the position shown, and 0.2887 inch is subtracted from the reading in the case of a U. S. tool and 0.1293 inch in the case of an Acme or worm tool. This applies in the case of a micrometer having the usual spindle diameter of 0.250 inch. If a micrometer with some other size spindle is used, the amounts to be subtracted from the readings on U. S. or Acme tools are obtained by multiplying the preceding values by the ratio of the spindle diameter to 0.250.



Figs. 1 and 2. Two Methods of measuring the Flat on U. S. and Acme Thread Tools

Fig. 2 shows the method of measuring the flat with a gear tooth caliper. If the measurement is made at a distance of ¼ inch from the point, the same values, *i. e.*, 0.2887 inch for U. S. and 0.1293 inch for Acme, are subtracted from the readings of the caliper to obtain the actual width of the flat.

Fig. 3 shows a gage for measuring the flat on U. S. tools, and Fig. 4 for making the same measurement on Acme tools. In both cases, the reading of the micrometer from outside to outside of the pins *B* and *C* is exactly one inch greater than the width of the flat. In using these gages, the thread tool is held with its point resting against the straightedge *A* and its sides between the fixed jaw *D* and the sliding jaw *E*. The distance from outside to outside of pins *B* and *C* is then measured with a micrometer and this measurement is one inch greater than the width of the flat. If these gages are carefully made according to the dimensions given, their use will enable the measurement of U. S. and Acme thread tools to be accurately made.



Figs. 3 and 4. Special Gages for measuring the Flat on U. S. and Acme Thread Tools

A tool capable of making these measurements even more accurately is illustrated in Fig. 5. The gage consists of a block of steel of about ⅝ by 1⅛ by 3¼ inches in size, having a 29-degree V-groove in one face. A hole is drilled through the block from the opposite face to the vee, and two springs *A* are provided to hold the micrometer depth gage in the position shown. In making this gage, the upper face is machined down until the distance from a 0.25 inch diameter plug held in the vee to the opposite side of the block is 1.12425 inch. This locates the vertex of the 29-degree angle at a distance of 0.500 inch below the face of the block. In using the tool, the depth gage rod is run out 0.500 inch, so that its end coincides with the vertex of the 29-degree angle, which represents the "zero" from which measurements are made. With an Acme tool held in the vee, the distance from this zero, as measured by the depth gage, is 1.9334 times the width of the flat. The width of the flat is obtained by multiplying the gage reading by 0.5173. It will be found convenient to have the preceding constants stamped on the front of the block and by preparing a table giving the gage reading for tools ranging from 1 to 12 pitch on the back of the block, the work of making calculations will be greatly facilitated.

Pitch	Gage Reading	Pitch	Gage Reading
1	0.7066	5	0.1334
1¼	0.5274	5½	0.1202
1½	0.4677	6	0.1094
2	0.3482	7	0.0924
2½	0.2767	8	0.0795
3	0.2289	9	0.0696
3½	0.1949	10	0.0617
4	0.1692	11	0.0551
4½	0.1493	12	0.0497

In the preceding table, a clearance of 0.010 inch is allowed. A similar tool for measuring the flat on U. S. thread tools was described by the writer in the May, 1912, issue of MACHINERY.

[For the tools shown in Figs. 1 and 2, the constant 0.2887 inch which must be subtracted from the reading for U. S. tools is 2 × 0.25 × tan 30 degrees. Similarly for Acme tools the constant 0.1293 is 2 × 0.25 × tan 14 degrees 30 minutes. In making the tool shown in Figs. 3 and 4, the pins *B* and *C* are set so that the distance from outside to outside is one inch when the gage is closed. In the gage for U. S. thread tools shown in Fig. 3, the distance 0.433 inch from the center of the pins to the top of the gage is determined by the ratio of the base to the perpendicular of a 30-degree triangle. In this case the base of the triangle is 0.250 inch, and this fixes the perpendicular as shown in the illustration. Similarly for the Acme tool shown in Fig. 4 the base of the 14 degree 30 minute triangle is 0.125 inch, and this requires the perpendicular to be 0.4833 inch. The constant 0.5173 for the tool in Fig. 5 is obtained from the relation of the perpendicular to the base of a 14 degree 30 minute triangle. Thus the width of the flat is twice the gage reading × tan 14 degrees 30 minutes.—EDITOR.]

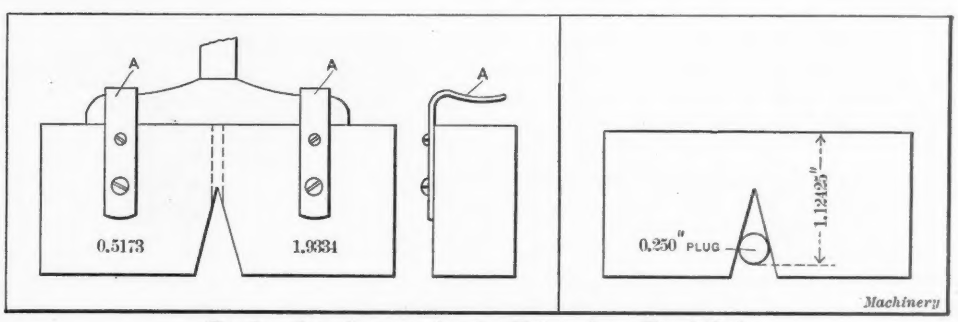


Fig. 5. Gage for measuring the Flat on Acme Thread Tool

* Address: New London, N. H.

COLD-HEADING—2

REPRESENTATIVE COLD-HEADERS—LIMITATIONS OF SINGLE- AND DOUBLE-STROKE HEADERS AND REHEADERS

BY CHESTER L. LUCAS* AND ERNEST W. DUSTON†

In the preceding article the principles of cold-heading, together with its early history and a general outline of the machines employed, were given. In this article a brief description of representative machines of each of the principal types of cold-headers will be given, with statements of the possibilities and limitations of the work which may be done on each of these classes of machines. From the preceding article it will be gathered that all cold-headers, whether of the crank- or toggle-operated types may be divided into single- and double-stroke machines on the one hand, and into solid- and open-die machines on the other hand. When we consider that single-stroke machines may be of solid- or open-die types, and double-stroke machines of solid- or open-die types either crank- or toggle-operated, and that the toggle-operated machines may be either one- or two-cycle type, it will be seen that to describe each of the combinations that are found in cold-heading machinery would be an endless job. In addition to the above-mentioned class of heading machinery, there are reheaders of single-, double- and triple-strokes; and in the special industries like that of tack- and nail-making the machines are still more special, but by describing the most common of the machines in general use an adequate idea of cold-heading machinery will be given, as the general operating principles are similar.

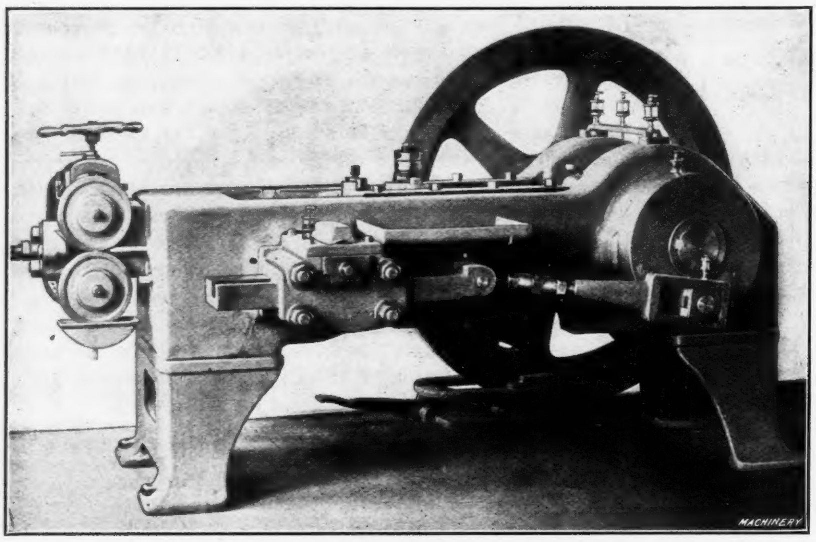


Fig. 16. Single-stroke Solid-die Cold-header—E. J. Manville Make

Single-stroke Solid-die Cold-header—E. J. Manville Make

The single-stroke solid-die header is undoubtedly the simplest of all, and for that reason has been selected for the initial description. This machine is built in six sizes; the smallest size handles wire up to 1/8 inch diameter and the largest, which is the machine illustrated in Fig. 16, handles wire up to 1/2 inch diameter. The frame is of very heavy section and the crankshaft, which is of large diameter, is made of forged nickel steel. The bushings which support this crankshaft have their bearings close to each side of the crankpin so that there is little danger of bending the crankshaft by the heavy work required in cold-heading. The wire is fed in from the front of the machine through the usual type of grooved roll and is lubricated by a reservoir below the lower feed roll. The cut-off is operated from the side in the manner described in the previous article and on this machine a safety connection is provided between the crank and cut-off cam slide. This is in the form of a shear pin so that if excessive load is placed upon the cut-off knife the machine will stop without doing damage other than shearing the safety pin. A patented form of cut-off knife is employed so that the blank will be held rigidly while being sheared and thus cut squarely. This is an essential feature on single-stroke machines, for as there is no preliminary or coning blow to centralize the stock, it must go to the dies in good condition after being cut off. The balance wheel is very heavy in design, and as it is essential that a heading machine be stopped at some point other than the center, a foot brake, shown in Fig. 16, is provided, so that the wheel may be stopped at any desired point in its revolution.

Single-stroke headers of the open-die type are not very largely used except in the wood-screw industry. The main point of difference between this type of machine and the one previously described is the die-operating mechanism, and this mechanism was described in general in the preceding article.

Double-stroke Solid-die Cold-header—Blake & Johnson Make

Fig. 17 illustrates a double-stroke solid-die header made by the Blake & Johnson Co. of Waterbury, Conn. This machine is one of the latest of its class and has some radical differences which are worthy of description. This is the first header to be made with a pan or tray between the frame and legs. In addition to catching dripping oil and odd ends of wire it furnishes a shelf for catching the finished work. This form of construction results in a more rigid machine than any of those types where long slender legs are employed. By observing the cut-off cam-slide mechanism at the center of Fig. 17, it will be seen that the cam groove is cut in the face of a segment rather than in a slide. This segment is pivoted on a stud as shown, and it is claimed that less power is required for its operation; in addition it makes a more compact arrangement. The connecting-rod which operates the cut-off cam is held by clamping at its operating end and when this clamp is set to the proper tension to do the work it acts as a safety device, allowing the

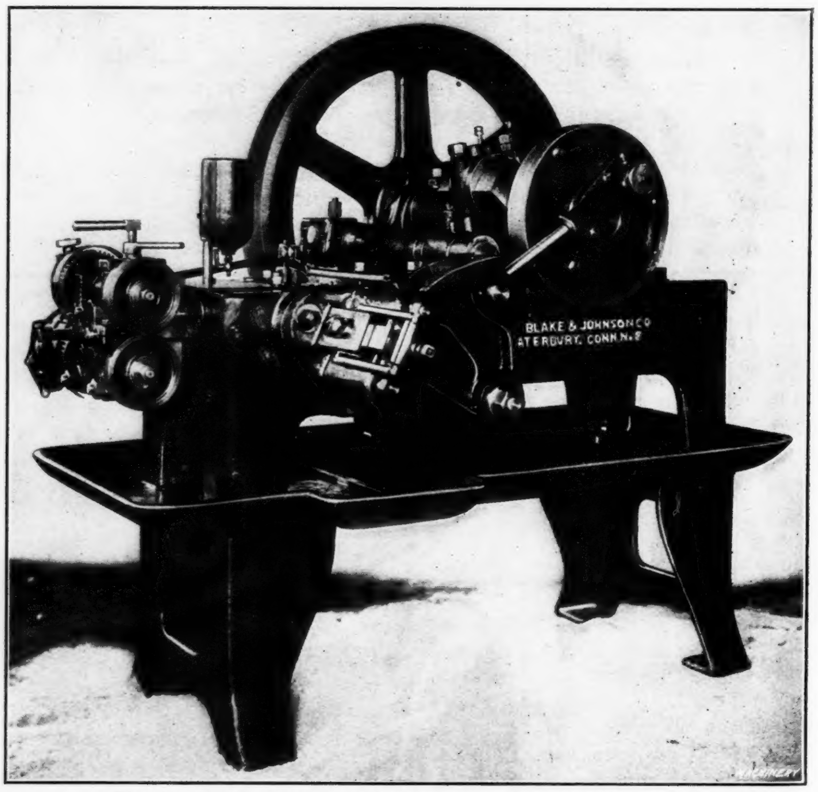


Fig. 17. Double-stroke Solid-die Cold-header—Blake & Johnson Make

*Associate Editor of MACHINERY.
† Address: 30 Revere St., Waterbury, Conn.

connecting-rod to slip if excessive strain is placed upon it. The distinguishing feature between single- and double-stroke machines is the rise-and-fall motion which must be used for raising and lowering the punch-block so that the two punches strike alternately on the head of the wire blank. The mechanism that provides for this is the Ingraham rise-and-fall motion which was fully described in the previous article. This type of mechanism has the advantage of being located at the top of the machine where it is most accessible and convenient to adjust.

On this machine lubrication is provided for by dripping oil from a cast-iron pot that is mounted on a stud at the head of the machine. From this pot the oil drips to a hole in the bed over the wire line from which it drops on the wire just before the latter enters the dies. Lubrication is an important feature on cold-headers especially when annealed steel or iron wire is being worked, because the lime film which remains from the annealing operation renders the wire hard to eject unless lubricated. The feed is operated by the three-pawl system so that the finest adjustments of feeding lengths may be obtained. The crankshaft bearings are cored out and provided

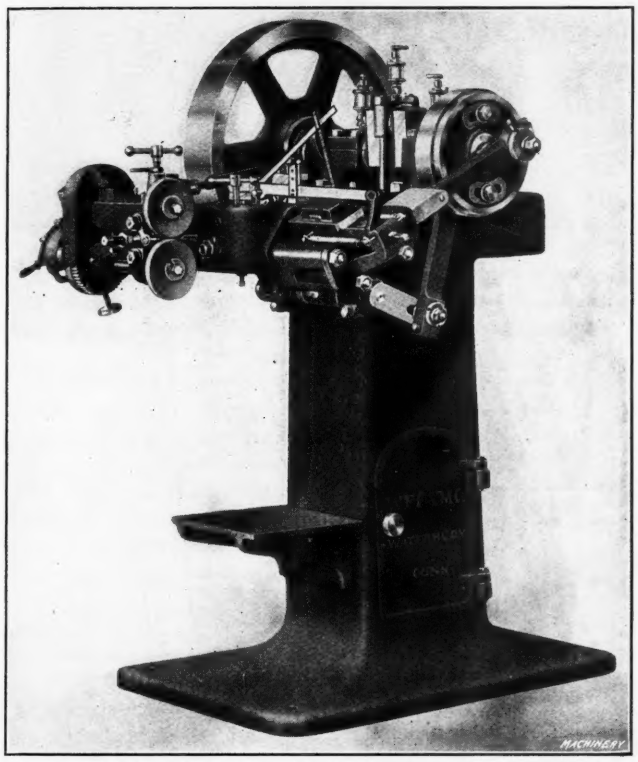


Fig. 18. Double-stroke Solid-die Cold-header, One-cycle Type—Waterbury Farrel Foundry Make

with chain oilers, which are a new feature on cold-headers. The capacity of this machine is the heading of blanks 3/16 inch diameter up to 1¼ inch length under the head.

Double-stroke Solid-die Header—Waterbury Farrel Foundry Make

One of the most popular of the double-stroke solid-die headers is that made by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. The machine is made in one- and two-cycle types, shown in Figs. 18 and 21, respectively. Both of these machines are of the toggle-operated type; the operating principles of one- and two-cycle headers were explained in the previous installment of these articles. The machine illustrated in Fig. 18 is the No. 0 size and has a capacity for heading wire up to and including one-eighth inch in diameter. It is designed to handle wire rivets or blanks up to one inch in length under the head, this being the largest amount of one-eighth inch wire that can be easily ejected from a solid die. This machine has been highly developed and embodies all the latest improvements in heading machinery. On account of its being of the one-cycle type, striking two blows to each revolution of the flywheel, the machine can be run at a comparatively slow speed and still obtain a large production. As is usual in solid-die machines, the wire is fed through feed rolls and a cut-off quill, and brings up against a rigid feed-stop so that the length of the feed is arbitrarily determined. The cut-off bar is of the usual type carrying a cut-off blade at its end and in most instances the cutting off and carrying is done with the aid of a "fiddle-bow" carrier.

This fiddle-bow carrier, perhaps, needs a word of explanation, and for that reason is shown in detail in Fig. 19. The purpose of this type of carrier is to back up the cut-off blade when severing the wire and assist in transporting the blank to the heading die. In Fig. 18 a view of the fiddle-bow carrier may be seen. From this, in connection with Fig. 19 which is a view of the die end of the machine from the inside, it will be seen that the mechanism consists of a carrier *A*, supported in a bracket *B* at one end, pivoted and actuated by end bracket *C* which is bolted to the end of the cut-off slide. At the operating end of carrier *A*, an arm *D* is pivoted,

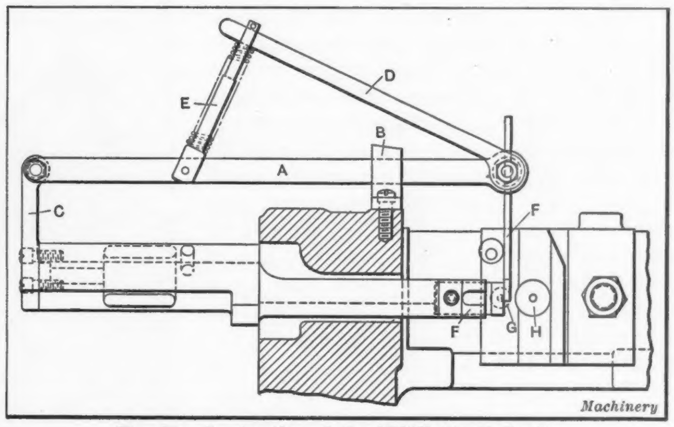


Fig. 19. Construction of the "Fiddle-Bow" Carrier

being normally kept in its uppermost position through a spring-encircling rod *E*. This rod is slotted at the upper section so that the arm *D* is free to move up or down. Finger *F* is the active part of this carrier, and when the wire emerges from the cut-off quill *G*, this finger is on the opposite side from the cut-off blade, being held there by pressure of the spring located on rod *E*. When the cut-off blade advances, the wire is prevented from being deflected at its outer end under the cutting pressure and is held perfectly square while the cut is being made. Now when the cut-off blade advances with the blank toward the heading die *H*, the fiddle-bow carrier mechanism also advances through contact of bracket *C* with carrier *A* which slides through supporting bracket *B*. After it is in the heading position and the blank partly entered into

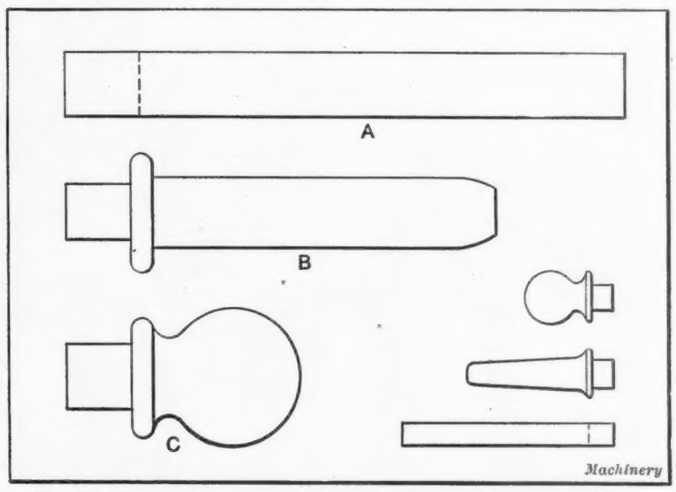


Fig. 20. Typical Examples of Reheading requiring an Open-die Machine

the die, the cut-off slide returns and finger *F* of the carrying mechanism snaps back over the wire and brings up against the new length of wire which has advanced through the cut-off quill *G*. The advantage in using this type of carrier is that the wire is supported behind the cutting action and a square end on the blank is the result. This is important, for if the cut is not square, the head of the finished product will be "lop-sided."

The heading operations are actuated by the well-known powerful knuckle-joint mechanism, of which the Waterbury Farrel Foundry Co. are exponents, and as was explained in the preceding article, the one-cycle type is characterized by

the striking of one long stroke and one short stroke of the heading slide as contrasted with two strokes of even length in the two-cycle type. The relative length of the two strokes may be governed by the design of the toggle mechanism, and it is customary to strike the long blow which does the coning or bulbing first. The second blow, which completes the heading, is taken care of by the short stroke; the reason for this is that concentrating the same amount of power into a short stroke gives a more powerful heading effect—just what is wanted for the final setting of the wire. On this make of machine, the heading slide has ample wearing surfaces and is gibbed for taking up wear.

The toggles, upon which so much depend in this class of machinery, are made of a special grade of bronze with adjustable steel side plates for taking up wear. The connecting toggle-pin is, of course, of tool steel, hardened and ground. One important feature of the toggle construction is that the machine can easily be brought "off centers" by hand, in case it should get stuck while operating upon a damaged blank or on account of excessive pressure. This construction also makes the setting of the tools easy when operating the machine by hand. The feed mechanism is of the usual type with two grooved cast-iron feed-rolls through which the wire passes. Cast-iron rolls are used as it has been found that the wire slips less than when steel rolls are employed. By means of a pawl-arm operated from an eccentric on the crankshaft, the length of feed can easily be adjusted even though the machine is in motion. The cut-off is operated through a cam-slide which may be seen at the right of the machine. This cam-slide operates back and forth through the cut-off bracket, thus actuating the cut-off blade. A safety slip device is provided so that if excessive strain is brought against the cut-off blade, the blade will not be broken but will be stopped in its action by the slipping of the safety mechanism. The punch-shifting mechanism is positive, the punch-slide being shifted both in its up and down position against stop-screws so that they will surely be in line when the respective blows are struck. Adjustment is provided so that the punches may be moved sidewise, up or down, or longitudinally. The longitudinal adjustment is obtained from a broad wedge in back of the toggles at the end of the frame. The knockout is located in the end of the bed and ejects the work from the die by means of a lever that pivots in the feed-roll bracket, operated from a cam on the crankshaft. The entire thrust of the heading blow is taken on a stop-screw which backs up the knockout pin and accurately determines the correct length of rivet made.

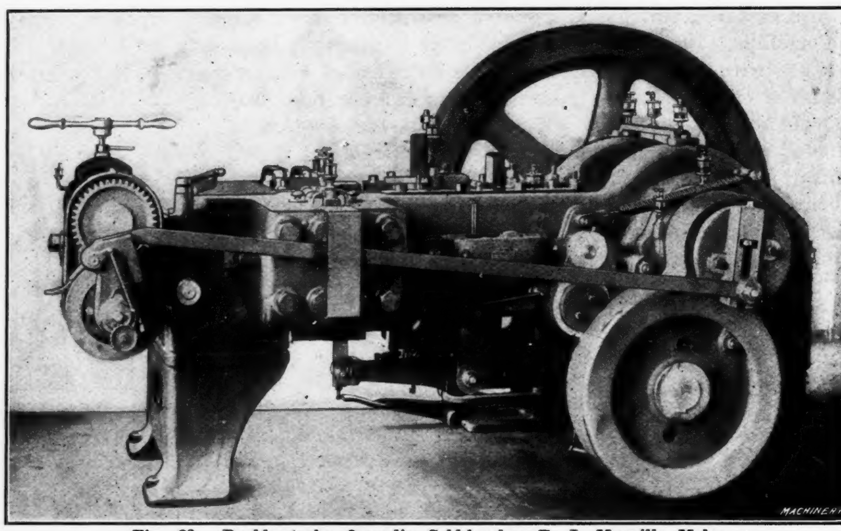


Fig. 22. Double-stroke Open-die Cold-header—E. J. Manville Make

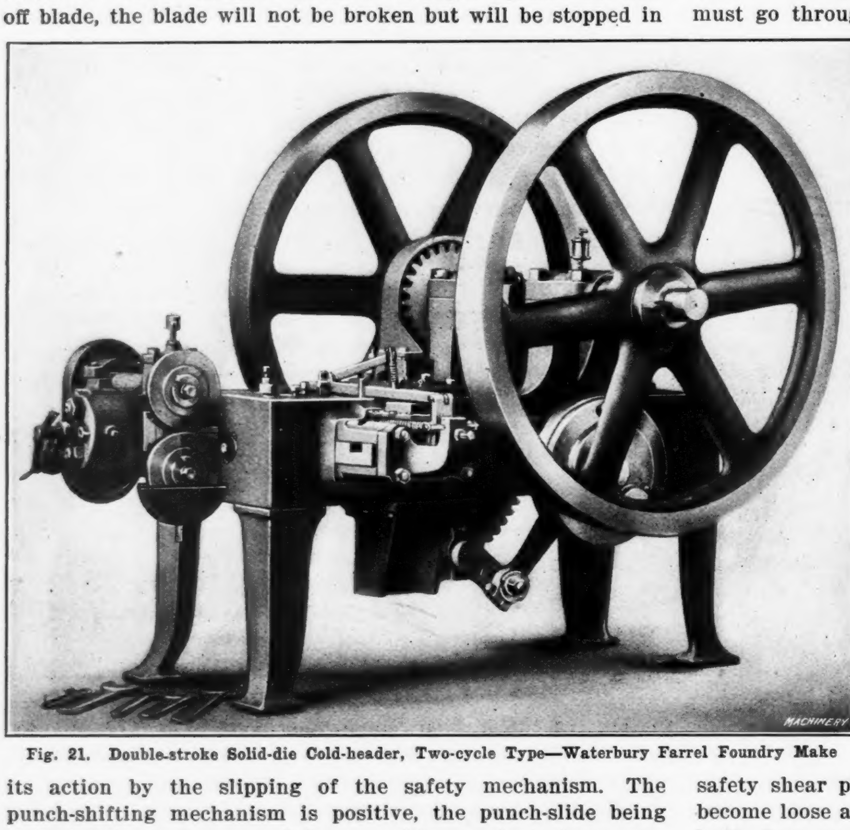


Fig. 21. Double-stroke Solid-die Cold-header, Two-cycle Type—Waterbury Farrel Foundry Make

Double-stroke Solid-die Geared Header—Two-cycle Type

The Waterbury Farrel Foundry Co. also makes a solid-die double-stroke header of the two-cycle type, and Fig. 21 shows the No. 3 size of this machine. It has a capacity for heading three-eighths inch rivets at the rate of fifty-five per minute. This is a geared machine of great power, and it requires two revolutions of the crankshaft to produce each rivet, in accordance with the two-cycle principle. This means that the feeding, cut-off and ejecting mechanism is geared down so that these functions operate only once while the heading slide is making two strokes. While this machine is more powerful than the one-cycle type, it is, of course, slower in its action, and the crankshaft and toggle mechanism must go through twice as many motions to produce a rivet as was the case in the one-cycle type. As in the previously described machine, the wire passes through the feed-rolls and cut-off quill and brings up against the feed-stop. The cut-off blade is actuated in connection with the fiddle-bow carrier which holds the blank to the cut-off blade and assists in carrying it to the heading position in line with the die. The upper heading punch strikes the first blow, forcing the blank into the die and centralizing the wire preparatory to the second blow which is struck by the lower punch, thus forming the finished head. The heading slide then draws back and the punches are shifted down ready to operate on the next blank.

The crankshaft is of large size and runs in bronze lined bearings on the larger machines. The flywheels, of which there are two on the large size machine, are held to the crankshaft between friction disks which slip and prevent damage to the machine should undue strain be imposed. The toggles on the machines are made of the best grade of cast iron, and provision is made for taking up the wear. The feed and cut-off mechanism are the same as in the type of machine previously described, and a safety shear pin is provided so that should the heading die become loose and project out far enough to prevent the cut-off knife from passing, or should the cut-off knife be obstructed from any other cause, the safety shear pin will be severed, causing no other damage to the machine. This shear pin is a plain straight piece so that it is a simple matter to insert a new one.

A relief motion can be furnished for this machine if desired. It consists of a mechanism that allows the knockout pin, against which the blank is forced during the heading

operation to draw back after the blow is struck. This allows the metal to flow into the dies more freely on the second blow, and is especially desirable on such work as requires squares or shoulders underneath the head. By a proper knowledge of the use of this relief motion, a great many difficult jobs of heading can be accomplished with facility.

Double-stroke Open-die Cold-header—E. J. Manville Make

Double-stroke cold-headers of the open-die type are the most complicated of the ordinary run of heading machines, for in

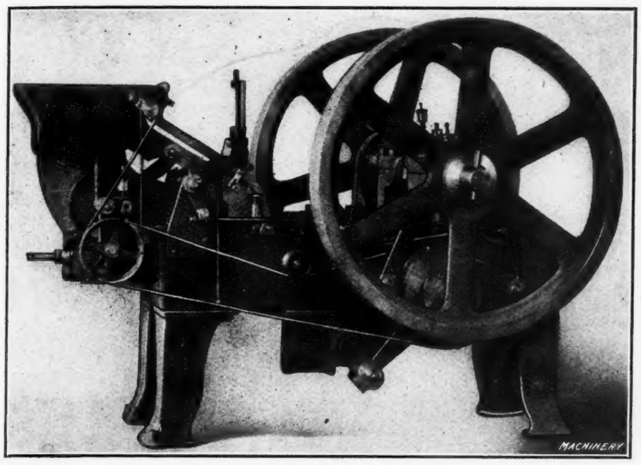


Fig. 23. Double-stroke Solid-die Reheader—Waterbury Farrel Foundry Make

addition to the rise-and-fall motion for operating the punch block, provision must be made for opening and closing the dies. In Fig. 22 is shown the E. J. Manville double-stroke open-die header. This machine is made in four sizes; the one illustrated is the No. 4 machine which handles wire up to one-half inch diameter. This header is of the crank-operated

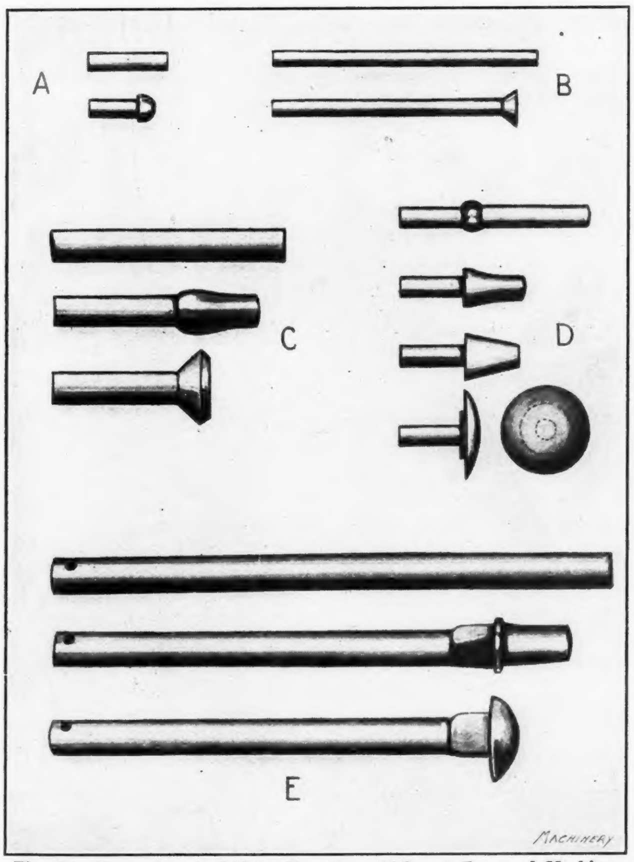


Fig. 24. Examples of Cold-heading from Different Types of Machines

type, and the wire enters through feed-rolls of the usual type and thence to its cut-off position between the square dies. The dies are then forced sidewise, shearing the wire and carrying the blank over to the heading position. When in line with the backing block, the first or coning punch centers and partly heads the wire, leaving it in condition for the second punch to finish the work. On this machine the punches are locked automatically in both up and down positions while the blows are being struck. Another distinguishing feature of this machine is that the wire feed is operated from the right-hand side of the machine as may be seen in Fig. 22. This leaves the front corner of the machine on the wheel side free from all mechanism so that the operator can observe the working of the tools easily.

The feed-pawl operates only at every second stroke of the machine, for it will be remembered that this is a double-stroke machine. By means of a handwheel which may be seen opposite the lower parts of the ratchet feed wheel a quick and accurate setting of the pawl may be made and it may be regulated while the machine is running. The wire feed is easily started or stopped by a hand lever.

A safety connection is provided between the die-operating cam and the crankshaft, in which there is a cast-iron plate. Should any obstruction prevent the dies from closing, this cast-iron plate will break and drop to the floor, thus instantly disconnecting the crank and cam-slide. An automatic throw-off instantly stops the wire from the feed when this safety device is brought into play. This machine is also provided with a foot brake to assist in stopping the header at the proper point.

Waterbury Farrel Foundry Double-stroke Solid-die Reheader

The varieties of reheaders are almost as numerous as all the other types of headers combined. The most common types, however, are the single- and double-stroke machines of solid- or open-die types. A representative machine of the double-stroke solid-die type is illustrated in Fig. 23 which shows a machine made by the Waterbury Farrel Foundry & Machine Co. This machine takes partly headed rivets or screw blanks after they leave the heading machine proper, and by means of a hopper feed, the blanks are automatically fed to the die in the reheader, thus making the operation entirely automatic. Automatic hopper feeds are of different types,

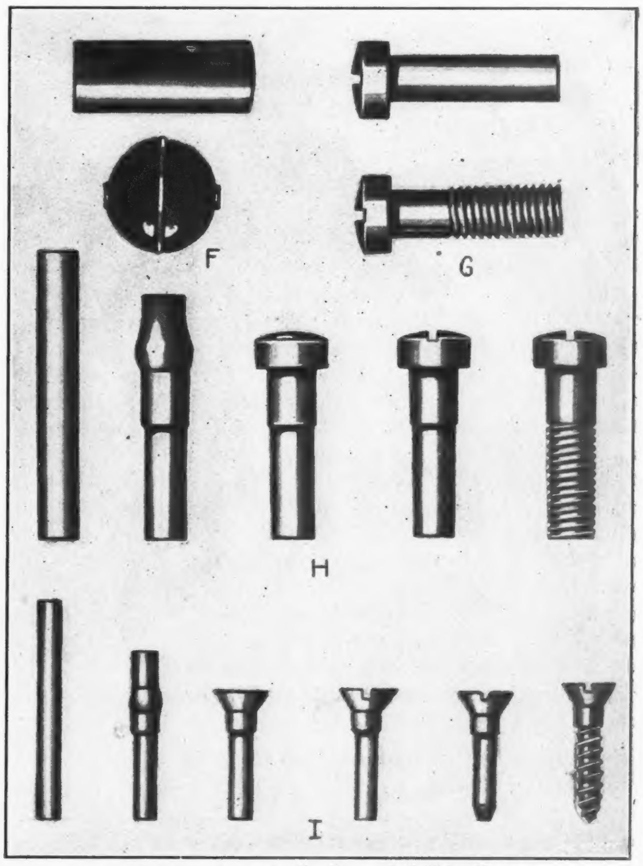


Fig. 25. Some Applications of Cold-heading

but the usual form consists of a hopper into which the blanks are thrown promiscuously. They are caught by their heads in a blade which has a slot at the top, slightly wider than the body of the blank. This blade rises vertically through the center of the hopper, and as it passes through the mass of blanks, some are sure to be caught by their heads and are carried to the uppermost position, where there is an extension of the slotted inclined chute. The blanks slide

down this chute, which may be seen between the hopper and the flywheel, Fig. 23, and a guard which passes over the heads of the blanks prevents any which are not in the proper position from passing. A transfer slide on a line with the dies supports a pair of fingers that pick a blank from the carrier slide and deliver it at the proper time to the heading die where the punches do the reheading. The operation of the heading mechanism is practically the same as that of the standard heading machines; in fact some of the types of standard heading machines can be fitted with reheading attachments. To do this it is necessary to take off the cut-off slide and substitute a transfer slide for conveying the blanks to

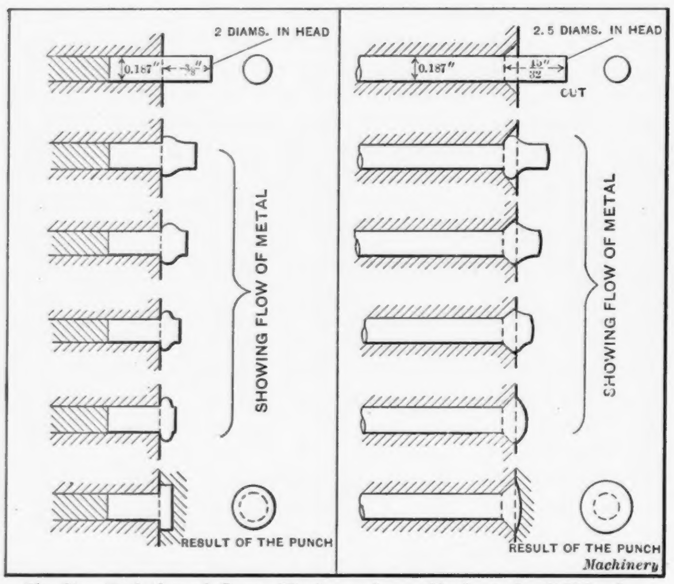


Fig 26. Evolution of Screw Blanks made on Single-stroke Cold-headers

the die. The reheader here shown, has a capacity for handling ⅜-inch wire, producing from 50 to 60 rivets per hour.

Cold-heading Operations

After describing the different types of cold-heading machines the next step is to take up the work for which each type is best adapted. By the process of elimination we can dispose of the open-die types of machines with the simple statement that, if the blank to be produced is over nine or ten diameters of the wire in length under the head it must be made upon an open-die machine. There are, of course, exceptions to this rule, but they are so special that they need not be considered here. In general, open-die machines are faster than solid-die machines of the same size, as the open-die cut-off mechanism is simple and much more rapid in its action. A rivet or screw-blank made on an open-die machine is easily distinguishable by light raised lines under the head and along opposite sides, caused by the metal being crowded into the crevices between the dies when the heading pressure separates them ever so slightly. The tools used in the open-die machines are more costly to make, and each set is good only for one particular length of rivet. In speaking of the wire in units of diameter, all sizes are included under the general rules. Thus, while only 1¼ inch of ⅛-inch wire can be ejected from a solid die, 3¾ inches would be the limit when working ⅜-inch wire. Similarly, when heading in the single-stroke machines, two and one-half diameters of any size of wire is all that can be put into a head.

Single-stroke Heading

Excluding reheading, we have only the single- and double-stroke heading to consider, since the heading operation on solid- and open-die machines are the same. It has been stated that the limit which may be reached with a single-stroke cold-header is the upsetting of two and one-half diameters of the wire into the head. By this we mean that no matter how soft the wire is, nor how carefully it is cut off, an unsupported length of two and one-half diameters irrespective of the size is all that can be controlled by a single heading punch. If a larger amount of wire is left unsupported and struck by the heading punch it will buckle at the center and be forced over to one side. A typical single-stroke solid-die heading job may be seen at *A* Fig. 24. The upper illustration shows the wire blank and the lower view the finished piece. At *B*, to the right, is a similar single-stroke heading job, but one which requires an open-die machine on account of its length. Now, turning to Fig. 26 the action of the metal under the heading operation may be followed. In the upper illustration the blank is represented with the metal for the head, comprising two diameters, extending from the die. The four illustrations which follow are intended to convey an idea of the way the metal spreads under the advance of the heading punch. The heading punch is, of course, in this case recessed to shape the fillister head which is to be given the blank. It will be seen that we have here the same result as was obtained in our preliminary experiment with the hammer in the first article. The metal, when first under pressure, commences to bulge next to the die and continues spreading out until confined by the limits of the recess in the punch. At the right-hand side of Fig. 26 we have a similar single-stroke heading operation taking place on a wire blank which was too long to be headed in a solid die. In this instance the head was oval, countersunk in shape and two and one-half diameters were upset in the head. This represents practically the limit of a single-stroke heading operation. The flow of the metal is represented by the four illustrations within the brace, and the lower view shows the completed blank in the die ready for ejection.

Double-stroke Heading

It is on double-stroke heading operations that we find the most interesting as well as the most difficult work. Referring to Fig. 24, a double-stroke solid-die product may be seen at *C*, and at *E* a double-stroke open-die product. The only reason for using the open-die machine for producing the work shown at *E* is on account of its length. The head in itself could just as well have been produced on a solid-die machine of the double-stroke type.

In all double-stroke heading operations the first blow, known as the coning blow, is used for centering and starting the heading operation, and leaves the wire in condition to be readily finished by the second blow which does most of the work. Referring again to *C* in Fig. 24, the upper view shows the wire cut off, and in the center is shown the result

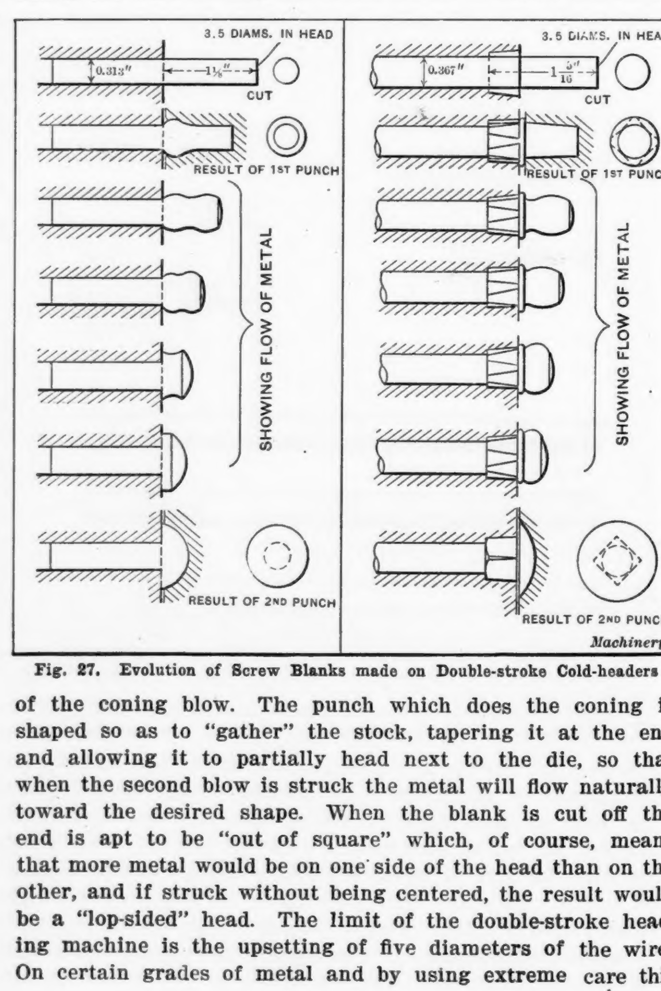


Fig. 27. Evolution of Screw Blanks made on Double-stroke Cold-headers

of the coning blow. The punch which does the coning is shaped so as to "gather" the stock, tapering it at the end and allowing it to partially head next to the die, so that when the second blow is struck the metal will flow naturally toward the desired shape. When the blank is cut off the end is apt to be "out of square" which, of course, means that more metal would be on one side of the head than on the other, and if struck without being centered, the result would be a "lop-sided" head. The limit of the double-stroke heading machine is the upsetting of five diameters of the wire. On certain grades of metal and by using extreme care this

rule may be slightly exceeded, but a five-diameter head is very nearly the limit. In Fig. 27, at the upper left-hand corner, may be seen the wire blank which has been cut off and is in the die ready for heading. In this instance there are three and one-half diameters of the wire left projecting from the die to be upset into the head. Directly below this may be seen a view which shows the result of the first or coning punch. The four views which follow show exactly how the wire upsets in forming the head, until at the extreme bottom is shown the completed blank, ready for ejection. On the right-hand side is shown the same series of views to illustrate the making of the head of a wagon bolt, which, because of its length, was made on an open-die double-stroke machine.

Many heading jobs are performed upon a double-stroke machine that would seem to come within the range of the single-stroke machines. The reason for this is that with the double-stroke machine the metal can be controlled to a higher degree of accuracy, and for that reason on accurate work the double-stroke machine is often used even though the head requires less than two and one-half diameters of the wire.

Fig. 25 is shown to illustrate some practical applications of cold-heading. At *F* is shown a blank and a headed ball, such as is used in the ball bearing industry. Heading machine manufacturers have given special attention to the heading of steel balls, so that cold-heading is now the usual way of producing ball blanks. At *G* is shown a screw blank and a rolled thread screw, which illustrate a condition of thread rolling practice. When the screw threads are to be rolled, and it still desirable to have the unthreaded section of the screw of the same diameter as the threaded section, the method of heading shown at *H* must be followed. In this section of the illustration the steps in making a rolled thread screw of uniform size are shown. First we have the cut off blank; second, the partly headed blank in which the section which is to be left unthreaded has been upset enough larger to match up with the diameter of the thread which will be rolled upon the lower section. The completely headed blank is shown next, then the slotted head, and last, the finished screw with the rolled thread. Similarly at *I* are shown the successive steps in making a wood screw, and the manufacture of machine and wood screws like those shown forms one of the most extensive uses for cold-heading machinery.

Reheading

Reheading is a more important branch of cold-heading than is generally recognized, and some of the "stunts" which may be accomplished with the proper knowledge of reheading machinery strongly emphasizes this fact. Reheading is usually necessary for one of two reasons; either to produce a head which would require too much work for the double-stroke machine to do, or to produce a head which is larger at the end than at the shoulders as in the case of hinge pins like those shown in Fig. 20. Even though the blanks are usually annealed before going to the reheaders, this operation is one which requires a great deal of force because the metal has already been compressed and is very dense before being reheaded.

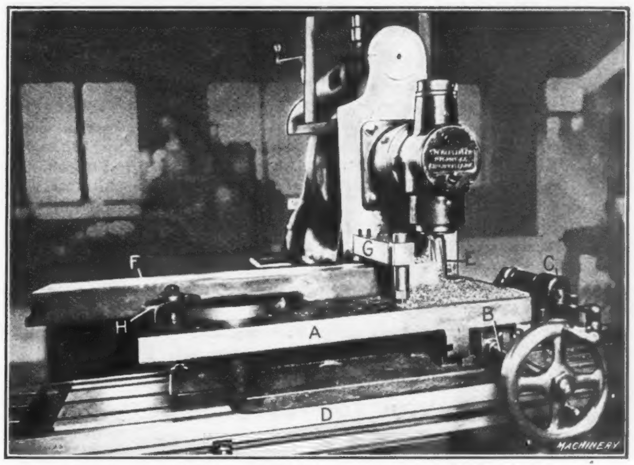
A good example of a reheading job is shown at *D* in Fig. 24. The first two pieces represent the work of the double-stroke solid-die heading machine, and from this point, the blanks are handled in a double-stroke solid-die reheader. The third illustration from the top in this group shows the result of the first reheading operation, and a plan and side elevation of the completed piece is shown beneath. The diameter of the head is very great, as compared with the diameter of the shank of the rivet and it will be readily appreciated that four operations were necessary to keep the metal under control and completely head the piece.

For producing hinge pins like that shown in Fig. 20, an open-die reheader is necessary. This is really a very interesting job of cold-heading, as there are eight diameters of the wire in this head. Two operations are necessary to bring the blank *A* into the position shown at *B* and these operations are performed upon a double-stroke header. After this point, the partly formed blanks are annealed and finished in a double-stroke open-die reheader, producing the result shown at *C* in two additional operations. The hinge pin shown at the right-hand side is similar but smaller.

LARGE CIRCULAR MILLING ATTACHMENT

The circular milling attachment shown in the accompanying illustration was designed by the Oesterlein Machine Co., Cincinnati, Ohio, for milling the arcs on the ends of its cutter grinder tables. This operation was previously accomplished on a regular circular milling attachment, but this proved to be inadequate for the work in hand. The chief reason for this was that the point of cutting was too far removed from the source of power, so that an excessive strain was imposed on the rotating mechanism of the circular milling attachment when it became necessary to carry the work around against a fair cut.

After trying different methods on the regular circular milling attachment with unsatisfactory results, the attachment shown in the accompanying illustration was made. The top



Circular Milling Attachment used by the Oesterlein Machine Co. for milling the Radius on the Ends of Tool Grinder Tables

part *A* of this fixture is cast with a projecting lug in which worm teeth are cut, which mesh with a worm mounted on the shaft *B*. The worm is driven from the universal-jointed shaft of the milling machine through the small fixture *C*, which is attached to the milling machine table and is of similar construction to the feed-box used for governing the table reverse. The bottom part *D* of the fixture is clamped to the milling machine table, and is located in proper alignment by tongues fitting in the table groove.

It will be noticed that the source of power is practically directly under the end milling cutter *E*, which is used for milling the arcs on the ends of the grinder table *F*. This feature enables heavy cuts to be taken with ease and dispatch. The work is clamped to the fixture by a swinging clamp *G* and two L-shaped clamps *H*, only one of which is shown.

D. T. H.

* * *

The enormous increase in number of internal combustion engines and the consequent greatly increased use of gasoline and fuel oil, has caused considerable apprehension as to the future of the internal combustion engine. If liquid fuel supply becomes inadequate to meet the demand, the future of the automobile and motor boat industries, to say nothing of other industries depending on the internal combustion engine, will be greatly restricted, if not crippled. Interest, therefore, is keen in the invention of Mr. Archibald Low, an English engineer, who has developed a gas engine using coal direct. The engine is virtually a gas engine with a gas producer in the cylinder. Mr. Low has built an engine of 80 to 100 H. P., that operates satisfactorily. Pulverized coal is fed to the cylinder by worm conveyers running in tubes located across the cylinder in the head. The tubes act as a gas producer and distill the gases from the coal during its progress through the cylinder. The ash is discharged on the opposite side of the cylinder from the coal feed hopper. The fact that an engine of this type is very compact, that all the apparatus is in one unit and that it can use coal of the cheapest grades, makes the development of extraordinary interest to engineers and all users of power. It has not been developed to the stage where it can be regarded as a competitor of the ordinary gasoline type for vehicles, but its compactness and simplicity give promise that it may become so.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, NEW YORK CITY

27, CHANCERY LANE, LONDON, W. C., ENGLAND

Cable address, Machinery New York

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Chester L. Lucas, Edward K. Hammond,
Associate Editors

William L. Cathcart, Consulting Engineer

Yearly subscription—Shop edition, $1.00; Engineering edition, $2.00; coated paper, $2.50; Foreign edition, $3.00. The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

JULY, 1913

NET CIRCULATION FOR JUNE, 1913, 26,114 COPIES

CIRCULATING CATALOGUES IN SHOPS

Progressive manufacturing concerns generally encourage their employes to read technical books and journals which better fit them for their work. Intelligent, well-informed employes familiar with improved machines and methods connected with their work are among the most valuable assets—for want of a better term—that a concern can possess. They are, as a rule, better contented than ignorant men, they take more interest in their work and have a wider range of subjects to think of. Reading and thinking awakens their interest and stimulates their ambition so that valuable inventions and improved methods originate where such men are employed. The atmosphere of such shops is agreeable to a stranger of the same character, and a mechanic coming to a plant of this type finds it congenial, if he too is of the progressive type. Thus kindred minds flock together, and the result is an expanding group of very desirable employes.

To foster the spirit of self-help and the desire to know more, is not always or altogether an easy matter. If undertaken in a paternal or patronizing manner, resentment may be aroused and the effort rendered fruitless. To advertise educational work is to defeat the object with some men; but if books and papers are provided unobtrusively and apparently incidentally at first, the taste for them is cultivated and stimulated.

An effective means for interesting men are the catalogues issued by other manufacturing concerns. These can be made part of a circulating library scheme, and instead of being carefully filed away where they rarely are seen, they can be made effective in placing descriptions of the latest machinery in the hands of men likely to study them with interest and profit. Not only will such study be beneficial in itself, but it will often result in suggestions for installing machinery and tools in the plant that will increase production and reduce costs. Concerns that circulate catalogues have found a keen interest manifested in them by men who rarely read a book of any kind. Studying catalogues often helps such men to form a taste for technical books, and especially for trade journals which bring the information in catalogues right up to date and keep the reader informed on all the latest ideas, developments and short cuts in his field. The employe who reads the literature of his trade becomes thoroughly familiar with the tools and methods employed in it, and learns to think and act for himself. Such a man is a constant source of original ideas in a plant and increases in value from year to year.

* * *

TAKING CARE OF CHIPS

The function of common machine tools is the production of chips. The removal of excess material leaves the form desired, whether the operation be drilling, milling, turning or planing. When the amount of material to be removed is small, or a small fraction of the total volume of the piece machined, the disposal of chips is readily accomplished, although usually it is done in a careless and untidy manner, but when the amount of material removed is relatively large and its removal is accomplished in a short time, the problem of taking care of chips is of considerable importance. A lathe turning a steel shaft for example, will soon accumulate a large pile of springy turnings which strew the floor and pile up on the machine. Chip-breakers are evidently required, and also chutes or conveyers for carrying the broken chips away as rapidly as produced.

Such conveniences are not likely to be provided for lathes except for those uncommon situations where the chip production is abnormal. But what can be done, and what should be done for milling machines particularly, is providing tables with wider channels for chips. More chip room would mean relieving the operator of the necessity of frequently removing the chips. The channels commonly provided are narrow, and a small narrow hand shovel must be used to clean them out. Wider channels would require less frequent cleaning, and when cleaning was necessary a broad shovel could be used to remove them quickly. The article by Mr. Smart in another part of this number is written in the light of experience with milling machines in general, applied to specialized manufacture. The importance of wider tables and larger channels for chips should be realized by milling machine makers especially, and machine tool builders generally.

* * *

SYSTEM FOR SYSTEM'S SAKE

Why are practical shop men often so antagonistic to shop systems? Is it not because these systems are often installed by office men who are out of touch with the actual shop conditions, who look upon the men working under the system as mere cogs in a machine, and who often require systems to be adhered to so rigidly that instead of the system being an auxiliary and helpful means to production, it becomes an inflexible law that can never be adjusted to suit conditions? In other words, they devise a system for system's sake. An interesting example of system running wild is told of a large eastern shop.

A machine had been promised for delivery on a certain date, and a heavy penalty had been prescribed in the contract of sale in case of delay of delivery. The foreman of the erecting department had been informed of this fact and was prepared to have everything ready for shipment on the date required. Some castings of a special alloy used on the machine, however, were ordered from another firm, and were not delivered in time to be machined and assembled with the machine, so that delivery could be made on the prescribed date. The foreman, eager to avoid the penalty that would be required of his firm, remembered that castings of the same alloy, intended for use on a larger size of machine built some time before, had been scrapped on account of a mistake in the machining operation. He looked them up and found that they were large enough to be worked over to fit the present machine. He had these pieces finished, assembled with the machine and the machine delivered on time. A few days later, the castings originally ordered for the machine were delivered. The foreman turned them over to the storekeeper in the unfinished state, but the storekeeper could not, under the system, accept the pieces before they had been machined and declared (on a special form provided for the purpose) to have been spoiled, and hence could be classified as scrap.

When a system is being operated for its own sake in this manner, it is time to reform it. Systems should facilitate production and should be flexible enough to permit of exceptions when the exceptions save time and effort.

SOME ASPECTS OF AVIATION

During the last five years, the governments of the United States and of European and South American countries have expended more than $86,000,000 in the building and operation of 2125 aeroplanes and 115 dirigible balloons. In four European countries, there was also raised by public subscription an additional sum of $7,000,000 for military and naval air-craft—a total expenditure of more than $93,000,000 during this period. The present plans of Germany alone call for an expenditure, spread over the next five years, of $37,500,000 for these purposes. The "nations' airy navies" grow apace.

A glance at the results which have been attained will show reasons for this feverish activity in development and construction. Air-craft are no longer the dream of a visionary, but factors of grave importance in the scheme of national defence. The aeroplane has made a speed of 114 miles an hour; it has traveled for thirteen hours at an average speed of 49 miles an hour; it has climbed to an altitude of 3.64 miles; and it can be built to carry a total load of more than half a ton. Communication by wireless can be maintained with it; in Europe, it has been equipped with machine guns; at a height of 3500 feet, it is, in general, immune from small arms and shrapnel fire, and, at one mile, it is both absolutely safe and invisible to the naked eye, although, even at that altitude, a trained observer can distinguish between troops of the various arms below.

The latest dirigible is a huge ship, whose gas-bags have a capacity of 688,350 cubic feet and a total lifting power of 24.2 short tons. Recent ships like this can float for fifty hours, have a speed of fifty miles an hour in favoring air, can cruise for more than 2000 miles, and each carries an armament weighing two tons. Their disadvantages are their great bulk, their vulnerability, and the sinking effect of rain and snow. The commercial Zeppelins are now making fairly steady runs in passenger service, and, with greater experience in handling them, their spectacular wrecks have ceased, while military authorities, in Europe at least, regard the dirigible, in its capacity for extended operations, as a formidable engine of war.

While the basic principles of the art of flying were virtually established in the United States by Prof. Langley, and its first successful applications were made here by the Wrights, its commercial development in this country lags so far behind that in Europe as to be almost negligible. There are now more than three hundred manufacturers of aeroplanes and their accessories, and but twelve of these are American. Our product in 1912 was 174 machines as against 1600 in France alone. In Germany, there are more than fifty companies engaged partly or wholly in this work.

One of the reasons for this stunted commercial growth is doubtless the long death-roll of the aeroplane, due so largely to reckless aviators in the early exhibition days. This stage has passed, automatic stabilizers have appeared, and the hydro-aeroplane, traveling in relatively steady air over water-courses, is now a reasonably safe machine. The main cause is, however, the lack of governmental encouragement. Despite the importance of aerial navigation in national defence, Congressional appropriations have been most meager—not more than half a million dollars from the beginning. Approximate estimates place the total investment, the world over, in aeroplane manufacture, aviation schools, etc., as $250,000,000. The proper equipment of our army and navy would restore and stimulate private interest and aid in giving the United States its rightful share in this great commercial opportunity.

* * *

THE MACHINIST

It is advantageous for the young man who has a liking for the machinist's occupation to go into the producing end of the works. Fifty per cent of the young men who complete a course in a technical school go into the drafting room. The work there is clean and honorable and necessary. It requires skill of hand combined with a considerable degree of technical knowledge. Sometimes, too, men advance from the drafting room to better positions. More often they stay right in the drafting room. When they rise to executive positions they, of course, receive desirable salaries. Draftsmen rarely receive more than $80 or $90 a month, however, and they are to be found in plenty. The supply seems to exceed the demand.

The same is not true of the man in the shops, speaking now of the intelligently trained machinist who takes a pride in his work and who is willing to strive, either individually or as one of the shop group, to increase production or better it. The results of his work are apparent in increased or improved production. The office man or the draftsman has not an equal opportunity. The results of his work are but vaguely apparent or not apparent at all. Moreover, there is a constant cry from the administration end of the factory for good executives, capable foremen and superintendents, as well as for men in the shops who can and will work with all their intelligence. That is the kind of a man who becomes an executive. Here the demand exceeds the supply.

Two phases of the situation perhaps render opportunity for the young, capable, enterprising machinist better than ever before. One is the automobile industry, which has enjoyed such a tremendous growth within a very few years. While the demand in this industry, because of the division of the processes of manufacture, for superior machinists is not so pressing, that very fact gives the ingenious young man a better chance. Most of the individual machinists in an automobile factory perform only a few operations. Each machinist works on some particular part of the engine or car, and he is thus merely a cog in a great manufacturing machine. Working in such a shop, however, the keen-eyed, observant machinist can often detect points at which production can be improved or increased without increasing expense, thus actually reducing the cost of manufacture. Suggestions of this character should always be gladly received by the manufacturer or his executives. Credit for them often means better positions for the man who suggests them.

The second factor which creates opportunity is the introduction into the shops of much foreign labor. They, as a rule, do heavy, mechanical work in a heavy, mechanical way. It is assumed that the bright American youths who study the machinist's trade are not only fitted to become capable journeymen but that they are properly ambitious to advance to higher positions.

An instance of rapid self-betterment is found in the cases of three young men who completed their apprenticeship four years ago. They immediately started a shop of their own in Muskegon. Now it is said that any one of the three can write his check for $25,000. And their foreman in apprentice days, who studied and worked with them, is now with the General Electric Co. in Schenectady, N. Y., on a salary approximating $6000 a year.

Such schools as the Lewis Institute, which offers a part time course for machinist apprentices, afford good opportunities for practical study leading to responsible positions. One graduate of this course had completed only the sixth grade in the public schools. When he began the machinist's course he had been in a machine shop six months and his work had consisted largely in keeping the shop in order. Seven months after finishing the two years' course his wages had increased 60 per cent, and now, less than two years after his graduation, he is assistant foreman in the shop where he was employed while taking the course.

Even though the young machinist were not ambitious, however, he might be assured of a fair living as a journeyman. At the present time shop men are paid 39 cents an hour, or about $3.50 a day of nine hours' work. Compared with some of the other trades the wage does not seem high, but there is little risk in the work and employment is steady. Trades that pay much higher wages are usually hazardous and irregular. Machinists on construction work, for example, receive 67½ cents an hour, or about $5.40 for an eight-hour day, because the work is more hazardous and is intermittent. Like virtually all the trades, the machinist's wages have risen. About ten years ago the shop machinist received from 23 to 27 cents an hour and worked ten hours a day. Then the erecting machinist got about 40 cents an hour.—*Chicago Daily News.*

* * *

Let us not forget while striving for higher efficiency, says one of our contemporaries, that better work and higher quality should be as important items as mere increase in production.

METHODS OF FINISHING METAL SURFACES

THE PURPOSE OF VARIOUS FINISHES AND HOW THEY ARE APPLIED

BY EDWARD K. HAMMOND*

The term "finish" is used to denote the final step in the production of any product, and the finishes applied to metal surfaces are obtained by a variety of methods. Among these, the following may be mentioned: Machining the natural surface of the metal to the required shape and smoothness; covering the surface of the metal with some protecting coating such as paint, lacquer, enamel or some other metal; or by heat-treating the metal to make it take on some desired color or property. Finishes are applied for three general purposes:

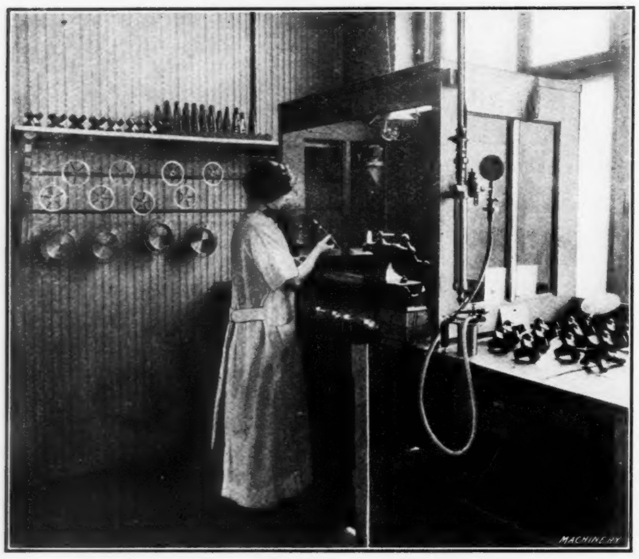


Fig. 1. Lacquering Round Pieces mounted in a Lathe

First, to improve the appearance of the product; second, to protect the metal from deterioration; and third, to add to the mechanical efficiency with which moving parts operate in contact with one another. These three considerations over-lap each other to a considerable extent. For instance, the parts of many mechanisms are carefully finished by lacquering or other means, the primary object of which is to make them attractive in appearance; at the same time this finish serves the additional purpose of protecting the metal from corrosion. Another example of this kind is seen in the case of cutlery and other steel products which are given an extremely smooth finish. Experience has shown that very smooth surfaces are not so likely to be affected by rust as rough surfaces, the reason being that there are no cavities to hold moisture that will act on the metal.

The question of the amount of finish which should be put onto machinery for the purpose of adding to its appearance is one over which there is considerable difference of opinion. Those who go to the extreme in one direction claim that no time should be devoted to the production of finish which is for a purely decorative purpose, the argument being advanced that the purchaser of the machine is paying in such cases for work that is of no value to him. The advocates of finish go to an extreme in the other direction, stating that the appearance of a machine is, to a certain extent, responsible for the ideals which a mechanic will attempt to attain in the work that he turns out on it. For this reason, they claim that it is desirable to produce machines upon which the finish has been brought to at least a reasonable degree of perfection. Both of these extremes are undesirable, the proper degree to which to carry the finishing of machine parts probably lying somewhere between the two. It will, of course, be obvious that different classes of machinery require the finishing of their parts to be brought to a different degree of perfection. In all cases, however, it should be borne in mind that any finish used must be of a character that will not deteriorate rapidly under conditions of service for which the machine is intended.

*Associate Editor of MACHINERY.

Finishes used by the Eugene Dietzgen Co.

In the factory of the Eugene Dietzgen Co., Chicago, Ill., which is engaged in the manufacture of surveyors' instruments, a number of interesting methods are used in finishing different metals to produce a variety of attractive results. The problem in finishing parts of surveying instruments is of the class referred to in which the finish must serve the double purpose of producing an attractive appearance and protecting the metal from deterioration. There are also special problems which have been solved by the application of finishes, two of which will be referred to in later paragraphs.

Silver Finish

In deciding upon the best finish for the compass box of a transit, several considerations are involved. First, the surface must be of a light color in order to enable readings to be accurately made; and second, the surface of the dial must be of such a nature that the surveyor will be able to read the instrument from all positions without being hindered by the glare of the reflected light. The finish finally adopted by the Dietzgen Co. to accomplish this purpose is known as the "silver finish" and is produced in the following manner: The dials consist of phosphor-bronze castings which are turned and ground to as smooth a surface as possible. It is impossible, however, to reduce the surface to the desired degree of smoothness by grinding, and for this purpose the surface is lapped down with a glass plate and pumice powder. The preparation of the pumice powder is as follows: Ordinary commercial pumice powder cannot be used for this purpose in the form in which it is put on the market, owing to the coarse particles which it contains. To remove these particles, the commercial powder is placed in a glass jar and water is added to it. The powder is then shaken up in the water and allowed to settle for several hours; this treatment causes the

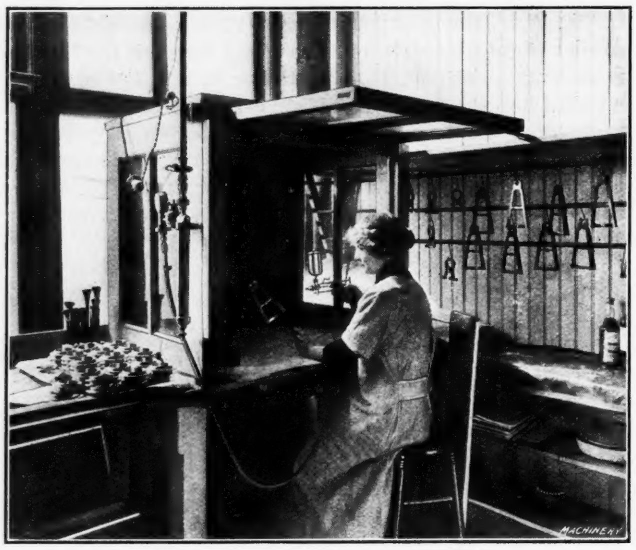


Fig. 2. Spraying Lacquer onto Work

coarser particles to sink to the bottom of the jar and the upper portion of the liquid containing the finer particles of pumice is decanted into a second jar. This process of washing is repeated three or four times, the upper portion of the pumice powder being transferred to the next jar in each case. The final powder obtained by this method, containing only the finest particles, is used for lapping down the dials. If the ordinary commercial pumice powder were used, the coarser particles would produce scratches that would spoil the appearance of the surface of the dial.

After being lapped, the work is ready to receive the silver finish. In the case of this silver finish, and also the three other finishes which will be referred to in the following paragraphs devoted to methods used by the company, it is necessary for the surface of the metal to be chemically clean before attempting to apply the silver paste. In the present case the

surface of the casting is thoroughly washed with a solution of ordinary salt and water. After the work has been cleansed by this means, the surface is rubbed with silver paste until an even coating of silver is formed over the surface of the dial. The dial is again carefully washed and allowed to dry after which it is graduated and then given a coat of colorless lacquer.

The silver paste is made up as follows: Five ounces of silver shavings are placed in a glass jar containing sixteen ounces of nitric acid, and after the silver has dissolved, chloride of sodium is added to the solution until no more white precipitate is formed. When this result has been obtained the white precipitate of silver chloride is filtered off and mixed with ten pounds of cream of tartar, care being taken to secure a thorough mixture. This silver paste is then placed in sealed opaque glass bottles to preserve it from the atmosphere and the action of the light until used.

Lacquering Copper Composition Surfaces

Different grades of metal are used in the construction of surveying instruments and the company has been able to secure some particularly attractive finishes by the use of suitable lacquers which bring out the color of the copper composition and at the same time protect it from tarnishing. The work is machined in any approved fashion to produce a smooth surface and is then thoroughly cleaned by washing with gasoline to remove any oil or other form of grease before the lacquering operation is commenced.

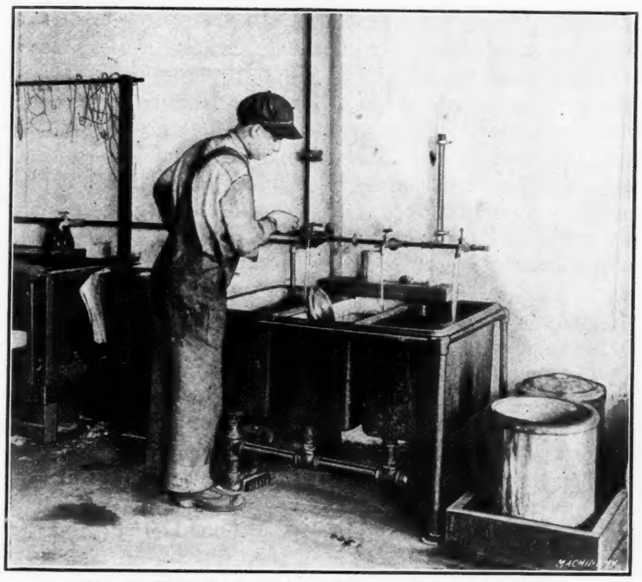


Fig. 3. Method of dipping Work in Bronzing Solution

In the case of circular surfaces such as the eye-pieces of transit telescopes, etc., the work is mounted in a bench lathe and the lacquer applied to the revolving surface with a camel's-hair brush. The work is given a number of successive coats, the number of coats applied depending somewhat on the character of the work in hand. Each coat is very thin and is dried by the heat of a Bunsen burner so that it is not necessary to lose the time which would be taken up in remounting the work in the lathe for each successive coat. In the case of other than the circular shaped pieces, the work is held by one end with a pair of pliers and the surface is lacquered with a camel's-hair brush. In finishing all classes of work in this way, care must be taken to have the lacquer spread perfectly smooth and considerable dexterity is required on the part of the girls who do this work.

In addition to the method of applying the lacquer with a camel's-hair brush, the company has recently adopted the method of spraying lacquer onto certain classes of work. The lacquer is held in a small pot and the flow of lacquer is controlled by a button which is pressed down with the thumb. When this button is depressed a stream of compressed air is admitted to a small injector situated in the tube leading from the lacquer pot to the nozzle. The action of this injector draws the lacquer up from the pot and discharges it through the nozzle onto the surface of the work. The advantage of this method lies in the fact that it is a relatively simple matter to secure an even distribution of the lacquer, and the work can be done with considerable rapidity. This method of lacquering is conducted in a draft-hood which is exhausted by an electric fan, so that the lacquer fumes are drawn away before they become objectionable to the operator. A careful study which has been made of the selection of the proper lacquer for each class of work has resulted in the production of a number of particularly attractive finishes, in colors ranging from lemon to a deep gold and with a high luster in all cases.

Bronzing

A number of the parts of the Dietzgen transits and levels are finished by a method of bronzing which can be applied to practically any metal. Work which is to be finished by this method is turned to the desired size and the surface is then finished as smooth as possible, the final surface being obtained by rubbing the work with fine emery paper. After the desired surface has been obtained the work is thoroughly cleaned by washing with gasoline, and it is then ready to be dipped in the bronzing solution. Two large earthenware jars are used for this purpose, the first containing the bronzing solution and the second water. The work is suspended by a wire and dipped into the bronzing solution for the required length of time to secure the necessary deposit upon the surface; it is then dipped in the jar of water and thoroughly washed, after which it is hung on a wire and allowed to drain and dry. At this stage the surface of the metal is covered with a deposit of dark colored metal closely resembling bronze in its appearance, and the surface produced in this way can be readily polished by rubbing with a soft cloth. After the preliminary finish has been put on the metal in this way, the work is transferred to the lacquering department and given the required number of coats of a suitable lacquer to produce a lustrous finish that will not be tarnished by exposure to the atmosphere.

The formula for the bronzing solution is: Arsenic, 2 pounds; oxide of iron, 4 pounds; muriatic acid, 8 gallons. This solution is mixed in an earthenware or glass jar and allowed to stand until all of the solid constituents have been completely dissolved.

Cloth Finish

The accuracy of surveying instruments would be considerably impaired by any considerable amount of expansion or contraction due to changes in temperature. It is obvious, however, that there are bound to be considerable variations in temperature while a surveyor is at work in the field, and to reduce the amount of expansion or contraction resulting from these changes in temperature, what is known as a "cloth finish" is applied to the parts of the instruments where changes of size would be particularly likely to introduce an error in the results. This cloth finish can be applied to any metal and would be useful in all work where changes of size due to changes in temperature would affect the accuracy. The method of applying is as follows: The work is turned to the required size and then thoroughly cleaned by first washing it in a weak solution of lye and afterward in gasoline or benzine. After removing all oil or other greasy matter in this way, the surface is given a coat of enamel and is then baked at a temperature of 300 degrees F. When the first coat of enamel has dried, a second coat is applied and the work is rebaked until the enamel has partially hardened; the work is then covered with fibrous material called "flint" or "flock" which is held by the partially dried enamel. After this coating of flock has been applied, the work is replaced in the oven and baked until the enamel is completely hardened. The appearance of the finish produced in this way closely resembles coarse cloth. Experience has shown that metal protected by a finish of this kind is not so readily affected by changes of temperature as it is when covered by any other finish which has been tried so that it will be seen that this cloth finish is particularly efficient in reducing expansion or contraction in the instrument. The finish cannot be washed off and an instrument covered with it is not damaged through being used in the rain.

American Gas Furnace Co.'s Carbonia Finish

The carbonia finish which has been developed by the American Gas Furnace Co., Elizabeth, N. J., consists of a method of coloring iron and steel surfaces with any of the temper

colors that are obtainable by heating steel to different temperatures. The operation is carried out in the rotary American gas furnace and a finish is produced which has a high luster. A well-known example of this finish is that on the action of Winchester repeating shot guns.

The following outlines the method of operating the furnace to obtain a black carbonia finish. The work is placed in the retort with about 8 quarts of crushed bone having granules ranging in size from 1/8 to 1/4 inch. The retort is maintained at a temperature of from 625 to 700 degrees F., and the result of this treatment is to give the surface of the work a preliminary oxidation which forms a foundation for the carbonia finish which will be completed in a subsequent stage of the operation. The work must be left in the retort for about an hour, or until it has reached a full black. If fresh bone is not available for this purpose it is possible to use the bone from a preceding charge, as the carbon will only have been partially removed from it; where it is possible, however, it is advisable to use fresh bone for the oxidation.

After the oxidation has been completed, the work is left in the retort and 8 quarts of bone mixed with about a pint of "carbonia mixture" is added to the charge. The carbonia mixture consists of a special oil which is compounded for this purpose by the American Gas Furnace Co. In this connection, it should be mentioned that it is of particular importance to have the carbonia mixture thoroughly mixed with the bone, in order to secure the best results, and a thorough mixture can be secured much more easily if the bone and carbonia mixture are warmed before the two are stirred together. If this precaution is not taken there is a possibility of the work coming out spotted. The length of time necessary to expose the work to the action of this mixture varies according to the character of the work, from one-half to three hours being required. The operator will learn from experience about the length of time that is necessary for producing the desired finish on any class of work, and when this time has been approximately reached, a sample is taken from the furnace, dipped in oil and then rubbed with a cloth. The surface of the work will be a dull gray when it is taken from the furnace, so that the condition cannot be judged until it has been polished. It this test shows that the desired finish has been obtained, the gas is turned off and the furnace is opened up to remove the work. The bone dust is sifted away and if the work is of a character to enable it to be treated somewhat roughly, it is dumped into a wire basket and then dipped in oil. In some cases it is not desirable to dip the work into an oil bath, and in such cases the treatment is obtained by tumbling it in powdered cork saturated with sperm oil. After the work has been cooled in this way, it is dried by tumbling in powdered cork or sawdust. Experience has shown that powdered cork gives the most satisfactory results, as the fine particles in sawdust are apt to form a paste with the oil and clog screw threads or other small openings in the work. It is possible to use the furnace in which the heat-treatment was carried on for cleaning the work in this way. When the work has been dried, it will also have been rubbed sufficiently so that it has the characteristic luster of the "carbonia finish." In cases where the very finest finish is required, the work should not be removed from the retort until the heat has been allowed to decrease sufficiently to prevent oxidation of the carbonia finish when it comes into contact with the air.

In the case of such articles as gun barrels and receivers, sewing machine parts and similar work which cannot be tumbled, special fixtures must be provided upon which these articles are held in the retort while the oxidation and the production of the carbonia finish are being carried on. For this purpose, supports are attached to the walls of the retort upon which the work is mounted so that it is kept covered with the crushed bone and carbonia as the furnace revolves but does not strike against other pieces of work in the furnace.

The preceding description of operating a furnace for the production of a carbonia finish applies to cases where a deep black color is desired. Other colors can be produced by this method, however, ranging from a pale straw to black with all of the intermediate colorations that can be produced by heating steel to different temperatures. Where lighter colors are desired the bone and carbonia mixture which has previously been used for finishing black work is recommended, and no additional carbonia is needed until the process has proceeded to such a point that no more smoke issues from the retort. If fresh bone is used, only about 1/8 of the amount of carbonia used for black work is added in producing the lighter colors. The length of time required to produce the finish depends considerably upon the character of the surface of the work and also upon the color of the finish which is desired.

Grinding, Lapping and Polishing

Many machine parts are finished by simply producing a smooth surface on the metal, and the most common method of carrying on this work is by grinding; but where a smoother surface is required than is possible to obtain by grinding, the finish can be brought to a more perfect condition by lapping and polishing. In addition to having its appearance improved by such a treatment, a surface finished in this manner is protected to a considerable degree from oxidation for two reasons. First, it can be rubbed with an oily rag so that all moisture is removed, leaving the metal thoroughly protected by a film of oil; and second, the roughness of the surface has been reduced so that pockets of moisture are not held on the metal.

Grinding and polishing is a common method of finishing surfaces of moving parts which engage with one another, and the perfection of the finish which is obtained is largely responsible for the efficiency with which the mechanism operates. A common example of this kind is the finish applied to the balls and races of ball bearings. In this case it is necessary to have the finish brought to the highest possible degree of perfection, because any roughness of the surfaces which engage with one another will set up a grinding action which will soon ruin the bearing. It may be mentioned in this connection that even the most highly finished surface is in reality nothing but a mass of minute scratches, and the problem in lapping and polishing is merely a matter of reducing these scratches to the smallest possible size. The surface of a properly finished ball bearing should be so smooth that no roughness can be detected with a powerful pocket magnifying glass. The surface produced on parts which move in contact with each other is the most noticeable factor in the finish which is given them, but there is another important factor in this finish, *viz.*, "hardening." The balls and races of ball bearings are hardened right to the center of the metal, and it is obvious that this hardening can really be classified as a finish because, although it does not alter the appearance of the work in any way, it is instrumental in preserving the finish which has been produced.

Another example of this kind is seen in the practice of casehardening the surfaces of gun-actions and similar parts in order to preserve the finish which has been applied to them. Work of this kind is first casehardened and then ground and polished. The object of this treatment is to preserve the finish, as in the class of service for which a gun is intended the surface produced by grinding and polishing would quickly be destroyed if the metal were left soft.

Painting

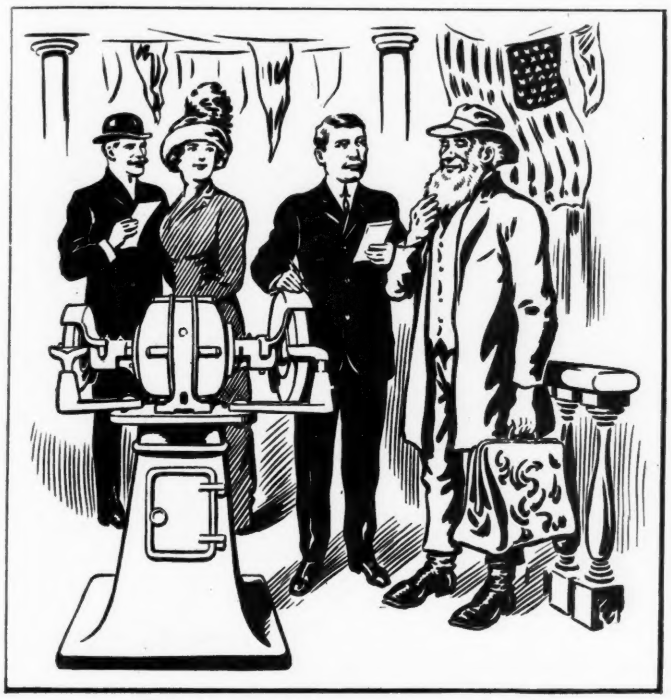
Painting is one of the commonest methods of finishing certain parts of a great variety of machinery, but although this practice is very general, there are one or two points that may not be understood by all. The roughness of the metal makes it necessary to apply a "filler" before putting on the paint, in order that the uneven surface of the metal may be thoroughly filled up and to prevent the painted surface from appearing rough. The method of using filler for this purpose is to mix it to a paste and rub it into the work with a putty knife, the paste being too thick to make it possible to apply it with a brush. After applying the filler in this manner, the work is given a number of coats of paint, depending on the perfection to which it is desired to bring the finish; on an average three coats of paint will be found adequate. Experience has shown that it is impossible to produce a good painted surface over iron that is badly rusted, and in some foundries a practice is made of painting the parts of the castings which are not to be machined in order to protect them from rust. Where this plan is followed, only one coat of paint is applied in the foundry. The remaining coats are put on after all of the machining operations have been completed in order to avoid marring the finished surface of the paint.

COUNTRY BLACKSMITH WANTS WIRELESS MOTORS

BY F. S. CULVER*

The experience of Mr. A. P. Press as related in "Wanted, A Hydraulic Engineer," in the March number of MACHINERY is indicative of the ignorance of the general public or individuals on matters pertaining to things outside their immediate zone.

The writer recalls an incident coming under his attention at the World's Fair at St. Louis in 1904. In the exhibit of one of the motor manufacturers there were shown several motor-driven buffers and grinders. As most readers know, these are simply a specially designed motor having suitable shaft extensions for carrying the grinding or buffing wheels and provided with suitable tool rests and wheel guards, the whole being mounted on a pedestal arranged to support the motor at a convenient height.



"Well, by gosh I'll take one of them machines!"

Inside the pedestal is mounted the motor starter, and as the motor is provided with dustproof covers, to the casual observer, nothing is revealed but the revolving wheels. In this particular exhibit the power circuit was wired to the motor from beneath the floor and into the pedestal in such a manner that no wires were visible.

One afternoon the demonstrator was showing the grinding possibilities of one of these machines to the usual crowd of spectators when a very ordinary looking and much bewhiskered gentleman entered the exhibit and after watching the performance for some time, commenced a series of questions as to the location of the factory that built the grinder, the speed at which it was running, how long it would last, the weight and finally, the price. All questions having been answered to the man's satisfaction, the demonstrator was surprised to have his visitor say, "Well, by gosh, I'll take one of them machines!"

It was then the demonstrator's turn to ask a few questions so that he could properly enter the order for transmission to the factory. "What is the voltage of your power circuit?" asked the demonstrator.

"The what?"

"The voltage of the power circuit or lighting circuit."

"Why, I never heard of such a thing. I have a gasoline light outfit in my shop."

"But are there no electric lights in your town?"

"No. But what's that got to do with this thing? Does this machine need to have an electric light to run by?"

"Not necessarily lights, but the motor needs to be connected by wires to a power circuit."

"Do you mean to tell me that thing needs power of some kind to keep it going?"

"Yes, sir."

"What's running it now?"

"It is being operated by power from the 220-volt power circuit of the exposition company."

"Well, how does it get into the motor?"

After this was all explained to him he remarked, "Well, by gum, I thought that was one of those wireless things that I've heard of, and that all you had to do with the thing was to set it down anywhere and it would go. You see, I am the leading blacksmith in my town and wanted to send something home that would make those fellows open their eyes." So the demonstrator lost his sale and the visitor walked away apparently disappointed and probably thinking the demonstrator was deceiving him for the benefit of the crowd that was standing around.

*Address: 217 South Dickinson St., Madison, Wis.

* * *

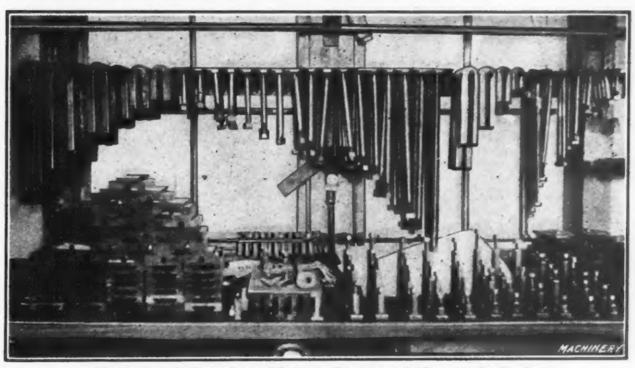
CONDITIONS GOVERNING EFFICIENCY OF COMPRESSED AIR EQUIPMENT

In a paper read before the Liverpool Engineering Society, Liverpool, England, Mr. George J. Gibbs pointed out the importance of several conditions which govern the efficiency of equipments operated by compressed air. Among these, the following may be mentioned. In any but the smallest installations, the design of the plant for the compression, storage and distribution of air warrants most careful attention. The air compressors should be supplied with cool, clean air which is as dry as possible. After compression, the heated air should be cooled before it is passed into the mains. Where this precaution is not taken, cooling in the mains will result in a deposit of water of condensation which will gradually collect and be driven forward with grit and rust until it finally causes trouble in the working parts of the apparatus. Compressed air can be conveyed through pipes for considerable distances with practically no loss, especially where the demand is intermittent and where a supplementary air reservoir is placed near the opposite end of the mains from the compressor. Although these are points which are generally recognized, their importance warrants keeping them before the attention of users of compressed air equipment.

* * *

PLANER CONVENIENCES

In many planing departments much time is wasted in looking up straps, bolts and jacks of proper lengths when setting up work on the planer. It is common practice to throw these useful adjuncts promiscuously into a box beside the planer. A convenient method of keeping these tools is illustrated in the accompanying view which was taken at the B. C. Ames Co.'s factory at Waltham, Mass. In their planing department, the machining of beds and other parts of their bench lathes is the principal work, and by using this method of keeping bolts, straps and jacks, the setting up of work is facilitated.



Method of keeping Planer Straps, Bolts and Jacks

From a wooden support along the wall, long hooks extend upon which the U-straps and bolts are hung. These are graded according to length, so that it is a simple matter for the planer hand to pick out a strap or bolt of the required length without sorting over a boxful of "junk." Similarly, screw jacks of different lengths are kept in graded rows upon the bench, and as the heights of these jacks are adjustable it is easy to get just the right support without resorting to shimming or papering up. A large assortment of these adjustable jacks has proved to be a time-saving investment. C. L. L.

SLIDE-RULE FOR SPRING CALCULATIONS

RAPID METHODS OF CALCULATION BASED ON BEGTRUP'S FORMULAS

BY JOSEF Y. DAHLSTRAND*

In designing springs, numerous calculations generally have to be made, such as changing the diameter, the number of coils and the size of the wire, in order to get the scale desired and to keep the fiber stress within safe limits. The purpose of the rule here described is to eliminate these calculations and place before the designer the entire number of springs which should receive consideration, so that he can select the one most suitable for his conditions. The rule consists of one set of scales shown in Fig. 1, pasted on a thin circular board, as shown in Fig 5; this part of the rule we will call the frame. The scales shown in Fig. 2 are cut out, thus making two separate rings to be pasted on a circular transparent celluloid plate, called "the runner," which is pivoted at the center as shown in Fig. 5. When placing the runner on the frame, the scales in Fig. 1 will appear outside, between and inside those shown in Fig. 2.

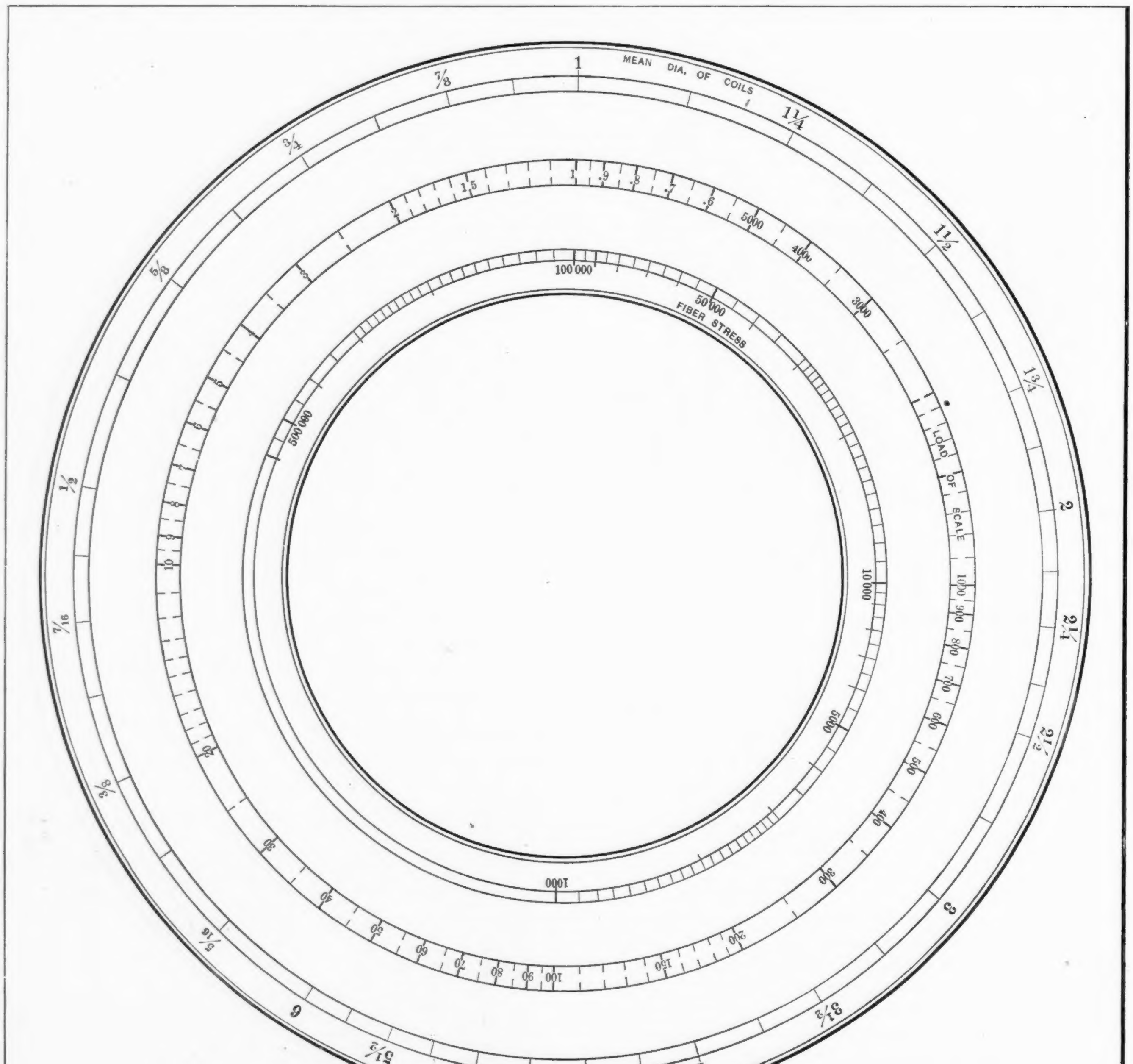


Fig. 1. Fixed Scales which are glued to Frame of Rule

The rule has been worked out from the well-known formulas developed by Begtrup and published in "Kent's Mechanical Engineers' Pocket Book." These formulas, with some modifications, are:

$$1 = \frac{8 P D^3 N}{E d^4} \qquad (1)$$

$$W = 0.3927 \frac{S d^3}{D} \qquad (2)$$

where

P = scale of spring (weight required to compress or elongate spring 1 inch);
D = mean diameter of coils;
N = number of coils;
E = torsional modulus of elasticity;
W = maximum load in pounds;
S = fiber stress in pounds per square inch;
d = diameter of wire.

The graduation of the rule is based on a value of $E =$

* Address: Wellsville, N. Y.

11,500,000, but, as will be seen later, springs with any modulus of elasticity can be figured. The assembled rule has seven scales. When determining the size of a spring, that is, any of the quantities D, N, d and P, the three outer scales and the middle scale are used; and when determining the fiber stress, the middle and the three inner scales are used. Loads and scales are figured in pounds, and diameters in inches.

The method of using the rule can best be illustrated by an example. (See Fig. 3.) The quantities $D = 3\frac{3}{4}$ inches, $d = \frac{7}{16}$ inch, and $N = 5$ are given. The scale of the spring is required. Place diameter of wire ($\frac{7}{16}$ inch) on runner opposite the mean diameter of coil ($3\frac{3}{4}$ inches) on frame, and read off the desired scale of the spring on rule marked "load or scale" opposite number of coils (5). The scale of spring is found to be 200 pounds. If, for example, the diameter of the wire had been desired, instead of the scale of the spring, the three quantities D, N and P being given, the order of operations would be reversed. After the number of coils (5) on runner had been placed opposite the scale of the spring (200 pounds) on frame, the diameter of wire could be read off on the runner opposite mean diameter of the coil ($3\frac{3}{4}$ inches) on the frame. It will readily be seen that, in a similar manner, any one of the four quantities can be determined when the other three are given.

Suppose that the spring has to carry a maximum load of 600 pounds, thus being compressed or elongated 3 inches from its free length. To find the stress, the four inner scales are used as in Fig. 4. Place the diameter of wire ($\frac{7}{16}$ inch) on runner opposite the load (600 pounds) on the frame, and read off the desired fiber stress on the frame opposite the mean diameter of coil ($3\frac{3}{4}$ inches) on the runner. The stress is found to be 70,000 pounds. In like manner, the order can be reversed, so that any one of the four quantities W, d, D and S can be determined, when the other three are known.

For small wire sizes the figures found by actual test do not quite agree with those obtained by Begtrup's Formula (1). A probable reason for this is that E, the modulus of elasticity, is slightly increased as the wire is drawn fine. In order to correct for this error and make it possible to figure springs of any material, with any modulus of elasticity, this rule has a correction scale, shown in Fig. 2, marked "moduli of elasticity." The figures shown on the scale are the moduli divided by 10^6. For steel wire sizes below $\frac{1}{8}$ inch, E can be assumed to equal 11,800,000. Bronze has a value of E of about 6,000,000. Suppose the scale of a bronze spring is found to be 200 pounds by the use of the four outer scales of the rule. The correct scale of the spring can be found by turning runner until $E = 11{,}500{,}000$ (on which the graduations of this rule are based) comes opposite 200 pounds on scale marked "load or scale," and reading off the figure opposite the correct modulus of elasticity for bronze, which is 6,000,000. The correct scale is 105 pounds. The modulus of elasticity varies for different qualities of steel and the most correct way would be to use moduli found by test of the material used. When figuring springs it should be borne in mind that the

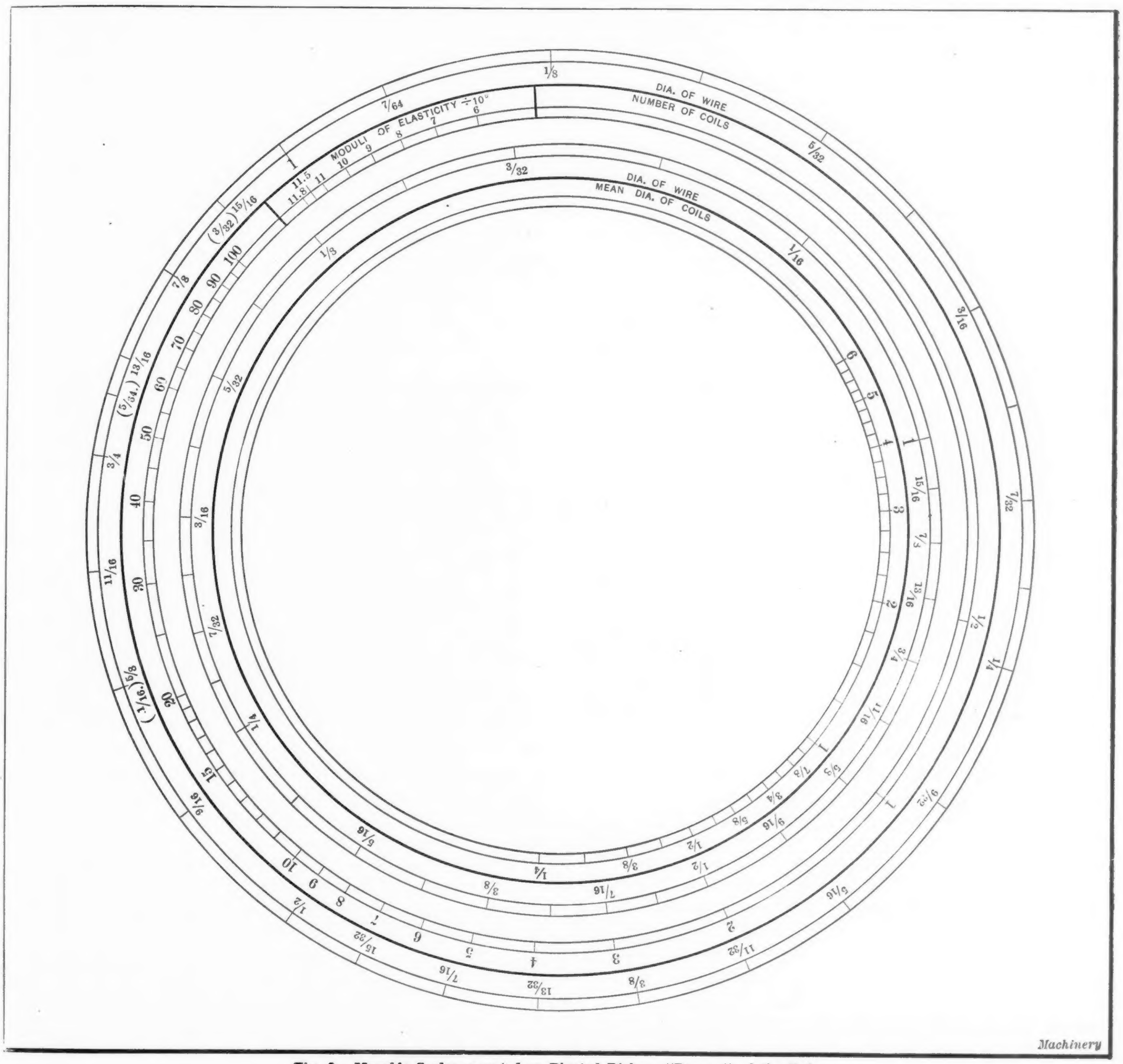


Fig. 2. Movable Scales mounted on Pivoted Disk or "Runner" of the Rule

working conditions of the spring determine the fiber stress that can be allowed. For a spring which is continually under its maximum load, but which must expand to its original free length when released, it is not advisable to allow stresses higher than 50,000 or 60,000 pounds per square inch; while for a spring which only carries the maximum load intermittently, it is safe to run the fiber stress as high as 100,000 pounds per square inch. By the use of this rule, all possible combinations of size wire and diameter and number of coils can be obtained for the scale and fiber stress given by simply turning the runner.

The scales of this spring rule are laid out by plotting the logarithms for the different quantities in Begtrup's equations on the circumference of a circle, and then drawing radial lines through the plotted points to any diameter desired. When taking the logarithms of both sides of Equation (1) we find:

$$0 = \log P + \log D^3 + \log N - \log d^4 - \log \frac{E}{8},$$

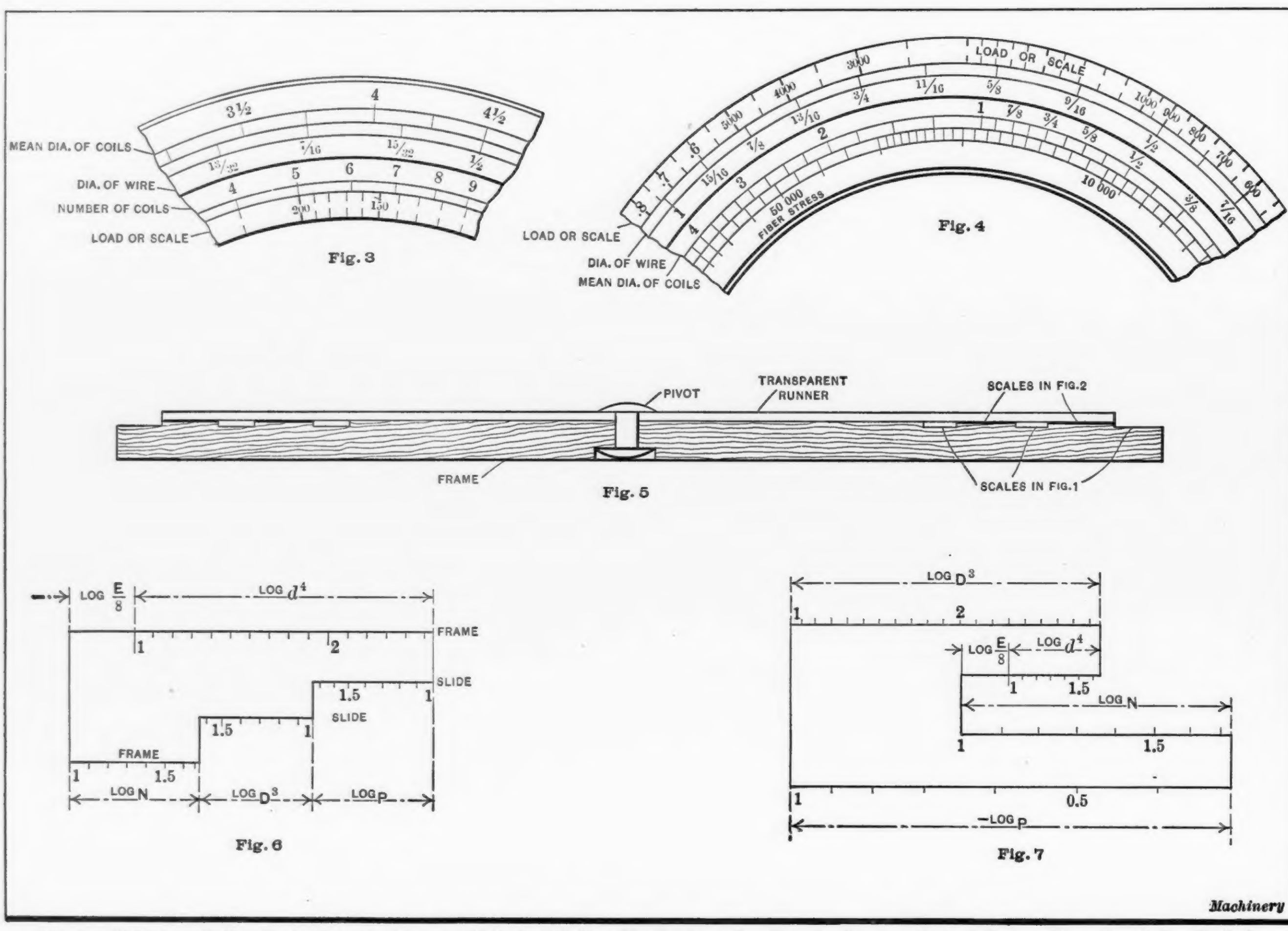


Fig. 3. Method of finding D, d, N or P. Fig. 4. Method of finding W, D, d or S. Fig. 5. Cross-section of Rule. Figs. 6 and 7. Methods of plotting Logarithms of Quantities in Begtrup's Equations

and $\log \frac{E}{8} + \log d^4 = \log P + \log D^3 + \log N$,

of which Fig. 6 shows a graphical demonstration. It can be easily seen that two runners or slides are necessary. But when taking:

$$-\log P = \log D^3 - \left(\log d^4 + \log \frac{E}{8}\right) + \log N,$$

and plotting the logarithms of P in the opposite direction from point 1, as shown in Fig. 7, only one runner or slide is found to be necessary, and the rule is based on this principle.

* * *

Shock absorbers on automobile springs are effective in preventing breakages, chiefly because of limiting the recoil. The primitive device used on carriages for the same purpose was a leather strap. One form of shock absorber that is claimed to be effective is a short opposing spring held by the regular spring clips above the long leaf of the spring so as to meet it on the recoil and check its movement. The device has the merit of simplicity and freedom from moving parts.

WEIGHTS OF FLAT ROLLED STEEL*

BY G. W. LINN†

The accompanying Data Sheet Supplement gives the weights of flat rolled steel per lineal foot for various gages and widths of stock. Referring to the supplement, it will be seen that gages ranging from 7-0 to No. 38 are given in the left-hand column, while different widths of metal ranging from 1/16 inch to 1 inch by sixteenths, and from 1 inch to 20 inches by whole inches are dealt with. The thickness of the metal in inches, corresponding to the different gages, is also given. The calculations are based upon the weight of one cubic inch of steel, which is 0.2834 pounds, the result shown in the tables being in pounds.

* * *

In spite of the extreme delicacy of many scientific instruments, notably those in which the services of the spectroscope and the electroscope are enlisted, the human eye and the sense of smell are capable, in regard to some substances, of detecting even greater refinements than these instruments. For example, according to *The Lancet*, the tinctorial power of some of the rhodamine dyes, which produce red shades, is so great that they show distinctive color to the eye when only a 0.000,000,000,1 part is present in a solution. The sense of smell is capable of detecting even smaller amounts of some particles, for the presence of attar of roses in the air is readily recognized when only 0.000,000,000,3 gram is present in one cubic decimeter of air. The spectroscope is generally regarded with wonder because of its power to detect the very minute quantities of matter, but compared with the human nose it is not a very sensitive instrument.

* * *

It is stated in the *Mechanical World* that the London fire department has used pure paraffine as automobile fuel for the last year with satisfactory results. The cost is about fourteen cents per gallon and the general efficiency is reported to be equal to that obtained with gasoline.

* With Data Sheet Supplement.

† Address: 1606 Broadway, Indianapolis, Ind.

TURNING VALVE NEEDLE POINTS IN A HARDINGE BENCH LATHE

The turning of the valve needle points for carbureters is a difficult operation, owing to the fact that not only must the angle of the point be exactly the same as that of the valve seat, but smooth finish must be secured as well, and the point must be perfectly round. Many manufacturers of carbureters produce these points by grinding, but this method has not been satisfactory in all cases, and an endeavor has been made to secure a greater proportion of good points, as those which leak, of course, have to be discarded. The Findeisen & Kropf Mfg. Co., Chicago, maker of the Rayfield carbureter, had considerable trouble in obtaining a leak-proof point by grinding, and as a last resort attempted to do this work on a Hardinge bench lathe. Fig. 1 shows this lathe set up for doing the work. The results were entirely satisfactory. The point, which is made from a steel containing a high percentage of nickel, is hard to turn, and to get a satisfactory job a high-speed steel turning tool is used. This is held in the toolpost in the usual manner and the turning is done by using the compound rest.

A special gage is used for setting the turning tool in the correct relation to the center of the work, so that it can be removed for grinding and replaced with the certainty that it will be absolutely on the center. Fig. 2 is a closer view of the equipment and shows a rough and finished point, that shown at *A* being finished, where it can be seen that the sharp point has been removed with a file. The body of the point, however, is not touched with the file at all, as it would be a difficult matter to secure uniformity if any hand work were done. The turning is watched by the operator through a magnifying glass in order to see that a perfectly smooth job is produced. With the exception of the special gage for setting the lathe tool, this lathe equipment is substantially the same as that furnished regularly by the Hardinge Bros. for ordinary work, and is supplied with their well-known ball thrust bearing on the spindle. This job shows up to good advantage the efficiency of this type of thrust bearing for small bench lathes, as it is evident that if there were the least amount of end play in the spindle an imperfect job would result. Further proof of the efficiency of this method of machining valve needle points is the fact that by grinding only about forty per cent of the points were good, whereas by finishing in the Hardinge lathe the average never runs below 98 per cent. D. T. H.

Fig. 1. Turning Valve Needle Points in a Hardinge Bench Lathe

* * *

It is announced that a well-known British electrical engineer has been successful in experiments undertaken with a view to obtaining higher efficiency in the steam turbine. The method is said to consist in re-superheating the steam after it has passed through one of the stages of the turbine, and using higher temperatures than ordinarily, these temperatures being made possible by coating the steel blading with nickel. A 5000-kilowatt steam turbine generator working on this system is said to have consumed only seven pounds of steam per shaft horsepower, and a still better performance, bringing the steam consumption down to about six pounds of steam per horsepower, does not seem improbable.

LIGHT WEIGHT RECIPROCATING PARTS FOR MOTORS*

During recent years, the problem of reducing the weight of reciprocating parts of gasoline engines has received considerable attention among automobile engineers. The first attempts in this direction were along the line of cutting down the weight of the cast-iron pistons, making the walls thinner and machining the inside as far as possible. Cast-steel pistons were then tried and experiments have recently been made with forged-steel pistons. Aluminum will not stand the wear to which a piston is subjected, but magnalium —an alloy of aluminum and magnesium which is lighter than aluminum—has been used successfully for a number of years in making the cylinders of gasoline engines where light weight is of great importance. As magnalium demonstrated its ability to stand the wear resulting from the use of cast-iron pistons in cylinders of this material, the natural sequence of events was to try the use of a magnalium piston in a cast-iron cylinder. The results have proved satisfactory.

The specific gravity of magnalium is 2.50, as compared with 2.56 for aluminum, and 7.50 for cast iron. The ordinary grade of cast iron used for pistons has a tensile strength of from 18,000 to 20,000 pounds per square inch. Magnalium has a tensile strength of about 23,000 pounds per square inch and is considerably tougher than cast iron. While not as hard as cast iron, magnalium is a better bearing metal. The results of experiments have shown that it is even better for this purpose than bronze or babbitt. Tests conducted at 280 revolutions per minute under a pressure of 250 pounds per square inch, showed the coefficient of friction of babbitt to be 0.0075, of phosphor-bronze 0.0069, while the coefficient of friction of magnalium was only 0.0056. Tests conducted under various conditions of speed and pressure gave results which are approximately the equivalent of the preceding figures.

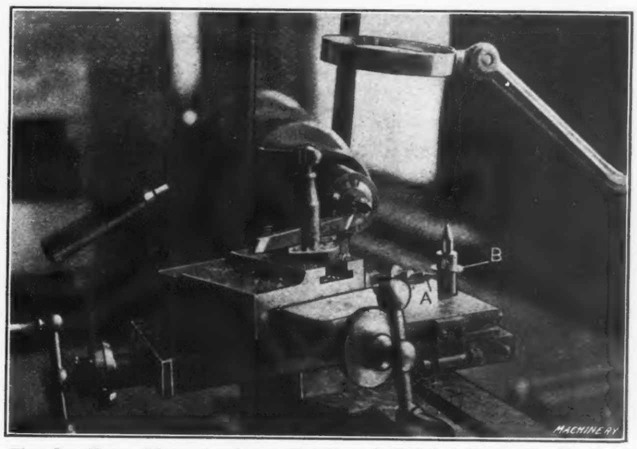


Fig. 2. Closer View showing a Rough and Finished Valve Needle Point

One of the interesting points in connection with the use of magnalium for pistons is that the melting point at atmospheric pressure is only 1256 degrees F. This melting point is considerably less than the temperature often attained in the cylinder of a motor. The reason that magnalium pistons are able to stand up in actual service is because the thermal conductivity of the metal is very high—fourteen times as great as iron—and as a result, the dome of the piston does not get as hot as that of an iron piston. The heat is carried away from the dome of the piston to and through the walls of the cylinder to the water jackets.

An advantage of the use of magnalium for motor pistons is the remarkable reduction of vibration which is effected. Another advantage is secured through the reduction of the inertia of the reciprocating parts. When the maximum force of inertia is reached at the end of the stroke, none of it can be transmitted to the flywheel and as a result, the entire force is received by the bearings at the ends of the connecting rod. This hammer-like action is reduced by the reduction in weight of the reciprocating parts which is effected through the use of magnalium for the piston material. At

* Abstract of a paper read by Maurice R. Machol before the Metropolitan Section of the Society of Automobile Engineers.

a given speed, the reduction of inertia forces reduces the amount of friction between the piston and cylinder walls, and also in the connecting rod and crankshaft bearings, with a corresponding increase in the horsepower of the motor. The result of this reduction of friction means that the motor can be run at a higher speed with a consequent increase of horsepower. The inertia increases as the square of the speed, and consequently as the speed increases the friction increases, until it finally reaches a point where the speed of the motor must be held down.

As magnalium is a good bearing metal, it is practicable to fasten the wrist-pin in the connecting rod and allow it to make its own bearing in the magnalium piston. Experience has shown that there is no tendency for the bearing to pound or wear loose when constructed along these lines. In recent years, several of the large motor car builders have laid stress on the ability of their cars to accelerate rapidly. The acceleration of the motor is dependent, to a large extent, on the weight of the reciprocating parts. If the motor has magnalium pistons, it is able to accelerate much faster, due to the reduction in weight. The claim has also been made that there is less tendency for carbon to deposit on the domes of magnalium pistons. Magnalium has also been successfully used for the connecting rods of gasoline motors. In such cases, the connecting rods have made their own bearings at both ends, and have demonstrated their ability to stand up satisfactorily.

* * *

A HIGHLY DEVELOPED BROACHING OPERATION

As an evidence of the progress which has been made in the broaching machine and its use may be cited a broaching operation which is being performed at the factory of the Kinsler-Bennett Co., Hartford, Conn., manufacturers of universal joints for automobiles. In Fig. 1 is illustrated two plan views of the piece which is to be broached, showing the work done at each of the two operations. Fig. 2 illustrates the special broaching fixture and broaches used for doing the work, and at *E* appears the rough steel forging upon which the broaching is done. This is one of the parts of a universal joint. It is one inch thick, having four roughly formed rectangular holes, which must be broached on all four sides, finishing each hole to an accurate size; moreover the broaching must be so done that the finished holes will all be equidistantly spaced from the central hole. This central hole is finished by drilling

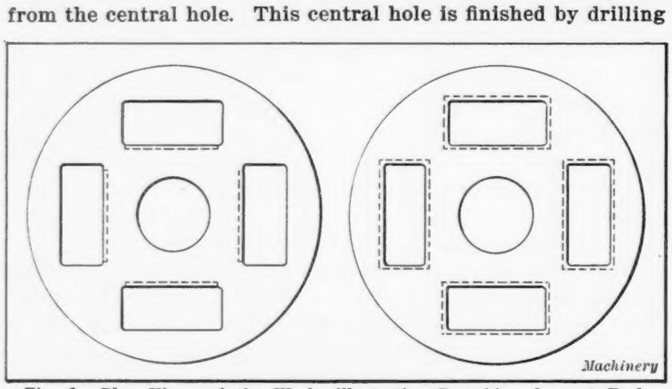


Fig. 1. Plan Views of the Work, illustrating Broaching done at Each Operation

and reaming and the outside edge of the piece is turned, so that the piece may be held by the edge.

Referring to Fig. 2, it will be seen that the broaching fixture consists of a very heavy faceplate casting *A* that fits on the head of the broaching machine, and this casting is bored out to receive the other half of the fixture *B*, which acts as a guide-sleeve.

The faceplate *A* is fitted with four hardened steel guides *C* which are adjustable radially by means of set-screws *D*. It will be noticed that these guide-blocks are slotted to receive and guide the broaches while they are cutting. The piece to be broached indicated at *E*, is a snug fit for the smaller bored hole in casting *A*, allowing it to seat close to the guide-blocks *C*. After being placed in this recess, guide-sleeve *B* which is a sliding fit for the large bored section in faceplate *A*, is inserted. This part of the fixture is also provided with four hardened steel guide blocks *F* which may be adjusted radially after the manner of chuck jaws. Guide-sleeve *B* while free to slide in faceplate *A*, is prevented from turning and throwing the two sets of guide-blocks out of line, by means of suitable tongues.

There are two operations required to complete the broaching on this piece. At *G* is shown the broach holder with the four broaches *I*, used for the first operation. One of the features of this job is that four cuts are made at each draw of the machine. The first operation is performed after adjusting the position of jaws *C* and *F*, so that when the four broaches *I*, held on broaching head *G*, start to cut, they will clean out a place on the inside edge of each of the four holes, leaving the forging with four cuts as indicated by the dotted lines in the left-hand view in Fig. 1. It will be seen that by

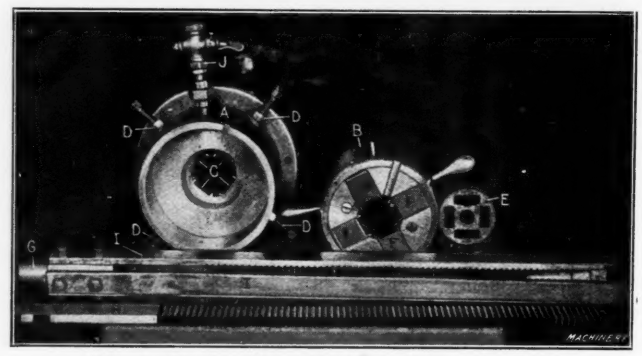


Fig. 2. The Broaches, Broaching Fixture and Work

adjusting the guide-blocks *C* and *F*, against which the blank sides of the first operation broaches bear, the broaching may be controlled as regards its distance from the central hole in the forging.

This completes the work done at the first operation. The second operation is performed with the aid of four broaches, one of which may be seen at *H*, Fig. 2, which are held upon the same broaching head *G*. These broaches are provided with one flat side which bears against the surface already broached. Teeth are provided on the opposite side and the two edges, so that the other three sides of each of the four holes are broached out true with the four surfaces already broached, thus cleaning the holes out on all four sides and insuring that the finished holes will be true with the central hole. Lubrication is provided through pipe *J* which enters the faceplate casting opposite the cutting point.

In broaching these parts, the entire lot is run through the first operation and then the broaches are changed and the second operation performed. The broaches are not removed from the machine after each pass, as is necessary in most broaching, for as they do not cut to the full width of the hole, and as they are spring-tempered and beveled at the ends, they may be pressed together and the forging slipped over them to the starting point. The broaches are made of slightly different lengths so that they do not all commence cutting at once. These pieces are broached at the rate of thirty-six operations, or eighteen completed pieces per hour. The tools used, as well as the broaching machine, were made by the Lapointe Machine Tool Co., Hudson, Mass. C. L. L.

* * *

ON FOLDING BLUEPRINTS

An engineering works using thousands of blueprints every year which go to practically every department in the plant, enforces rigorously a plan of uniform folding. The blueprints are made in standard sizes, and each of these sizes is required to be folded in a special manner. The first requirement is that when the folding is finished the folded sheet be approximately 8½ by 11 inches. The second requirement is that it be folded with the face out, the title corner being exposed. This title corner is always visible as a consequence, for filing purposes and by using the outside, or "face out," system, it is often possible to get the information required from the blueprint without unfolding it entirely. In this particular the old system of folding a blueprint so that the outside was the blank side, caused much waste of time.—*Things Technical.*

SEMI-AUTOMATIC INDEX-PLATE DRILLING MACHINE

The illustrations show an interesting machine designed and built by the Oesterlein Machine Co., of Cincinnati, Ohio, for drilling the holes in index plates used on the dividing heads of its milling machines. Inasmuch as this machine is entirely automatic in its operation and embodies some interesting mechanical features in its construction, a complete description will be given. Fig. 1, which shows a rear view of the machine, illustrates some of the principal mechanisms

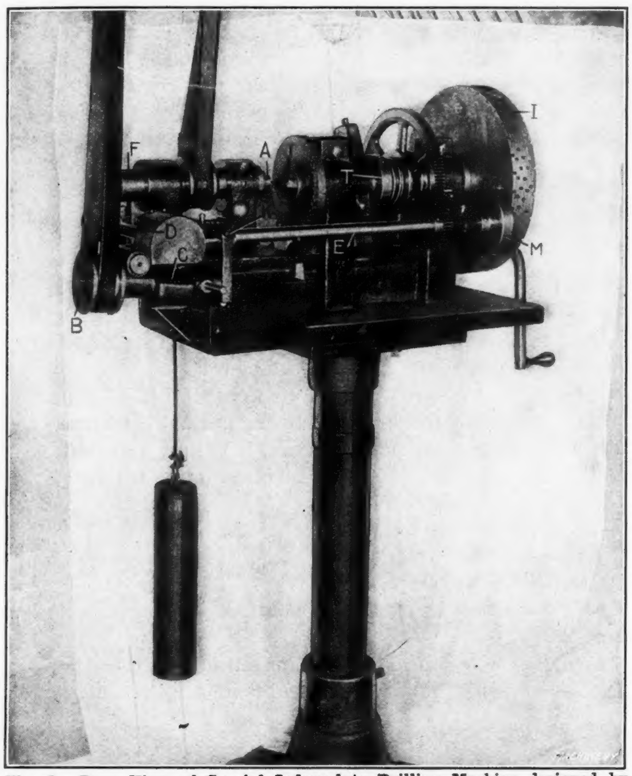


Fig. 1. Rear View of Special Index-plate Drilling Machine designed by the Oesterlein Machine Co.

and indicates how the power for operating the machine is derived. It will be noticed that all of the movements of the machine—with the exception of the rotation of the drill spindle *A*—are controlled by power received from the pulley *B* which is belted to a countershaft. This pulley drives a "drop" worm *C*, which meshes with a worm-wheel on shaft *D*, the latter being connected to shaft *E* through bevel gears.

The spindle *A*, in which the ⅛-inch flat drill is held, is rotated at about 1500 revolutions per minute, and is retained in a sliding sleeve *F*, the latter being forced forward by a cam on shaft *D*. This cam comes in contact with a lever *G* (see Fig. 2), which is fulcrumed at its lower end, and has teeth cut in its upper end that mesh with corresponding teeth in the sliding sleeve *F*. This sleeve is returned by the lever through the action of a spring, and the sleeve does not rotate, but is slidably keyed to the bearings in which it moves back and forth. The drill head *H* is machined on its lower face, fits over dovetailed ways on the bed of the machine, and is operated by a 4-pitch screw for changing the position of the drill for drilling the various rows of holes in the index plates. The manner in which this drill head is moved in toward the axis of the work spindle will be described in connection with the operation of the front shaft.

By referring again to Fig. 1, it will be noticed that the main or work spindle is driven by a pinion on the shaft *E*, which meshes with a large spur gear on the spindle. The hub of this large spur gear is held between friction collars by the stiff coil spring shown, the collar to the right of the gear being fastened to the work spindle, while the washer on the left-hand side is free to slide. The tension of the coil spring is controlled by the split nut *T*. The work spindle, in addition to carrying the index plate to be drilled, also carries the group of master index plates *I* of which more will be said later.

In order to illustrate how this machine operates, we will assume that an index plate has just been finished, and that the machine is inoperative. The first thing that the operator does is to wind up the wire rope on the front shaft, bringing the lever *L* and drill slide back to the starting positions, after which he removes the finished plate by unscrewing the cap-screw *J* and taking off the washer and index plate. A plate which is ready to be drilled is then put on the spindle and the screw tightened. The operator forces the lever *K*, see Fig. 1, to the right, thus bringing the worm *C* into mesh with the worm-wheel, whereupon the machine begins to operate. The drill now advances into the work, and as the sleeve carrying the drill spindle is about to retreat, the various indexing mechanisms come into play. The first movement which takes place is the releasing of the lock from the master index plates *I*. This is accomplished by lever *L*, which is fulcrumed on the front shaft and operated by the cam *M* located on the rear shaft *E*, the movement being transmitted through a plunger *N* coming in contact with an extension of the lever.

After the lever holding or locking the master index plates is forced back, the master plates are indexed, through the large gear and friction collars, into the position for drilling the next hole in the circle on which the drill is at work. When the master index plates have again been locked by the lever *L* through the medium of a compression spring located below the fulcrum of the lever, the drill sleeve is advanced and another hole completed, these operations being repeated until all the holes in that circle of the index plate have been drilled. After the work has made one revolution, the lever *O* is operated upon by a pin in the dog *P*, which is held on the work spindle and rotates with it. The position of this dog on the spindle can be changed, relative to the cam operating the lever holding the master index plates, so that the proper timing of the mechanism can be obtained. As soon as lever *O*

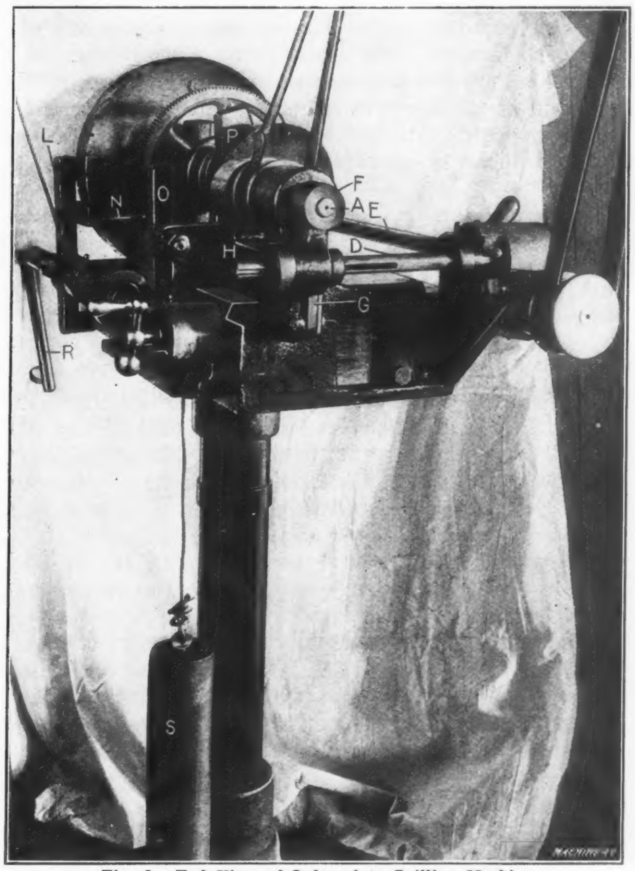


Fig. 2. End View of Index-plate Drilling Machine

is operated upon by dog *P*, its lower end is withdrawn from the cam on the front shaft, allowing the latter to make one complete revolution.

It will be noticed that the front shaft, see Fig. 2, is rotated by a wire rope wound around it, to which a weight is attached. This wire rope, when "run down" at the completion of each plate, is rewound around the shaft by the handle *R*. Now as the front shaft, on which the lever *L* is held, is provided with a 4-pitch screw, it follows that as this shaft makes one revolution, the lever will be moved along the shaft in a lateral direction through a space of ¼ inch, thus

engaging with a notch in the next master index plate in the line. Again, as the front shaft is connected to the screw operating the drill slide, this also is given one revolution, and consequently carries the drill in ¼ inch closer to the axis of the work. The weight S is used to hold the drill slide back against the operation of the screw to prevent lost motion. The cycle of operations just described is continued until the last row of holes in the disk has been completed, when the drill slide upon reaching its final inward position, touches a lever which disconnects the worm from the worm-wheel, and thus stops the operation of the machine.

As the indexing of the work is accomplished by a cam on the shaft E, it is evident that an indexing takes place at every revolution of this shaft, but as this movement is controlled by friction, it will be seen that the number of indexings is dependent on the number of notches in the master index plates. The dog which operates the lever for releasing the front shaft is fastened directly to the spindle that carries the index plate, and hence, as one row of holes is completed, this dog comes into action to move the lever L over in line with the next master plate in the group, and also moves in the drill head towards the axis of the work a distance equal to one revolution of the screw—or ¼ inch.

The master index plates, which are made from a high carbon steel and left soft, are cut in an automatic gear-cutter. Each disk is made ¼ inch thick, and is provided with the same number of slots that are required in the circle of holes for which it is made. The group of index plates are bolted together as shown, and are keyed to the work spindle of the machine. The notches in all the disks start from the keyway, and the master plates are grouped together so that the disk having the greatest number of slots is located closest to the work, the number of slots gradually decreasing toward the outer end of the row. The drill begins operating on the row of holes on the largest circumference, and gradually works in toward the center. The work turned out by this machine is accurate enough for all practical requirements, and as all the movements are entirely automatic, it requires very little attention. One of the flat drills used produced 35,500 holes before requiring resharpening. D. T. H.

* * *

DIMENSIONS OF SPIRAL GEAR TEETH

BY ARTHUR C. MAXFIELD*

In cutting a coarse worm or spiral gear it is customary to make the tooth measurements smaller than the dimensions called for on the cutting card in order to have the gear run properly with its mate on the correct center distance. Workmen have found from experience that the spiral gears made with the correct size of teeth bind when they are set with

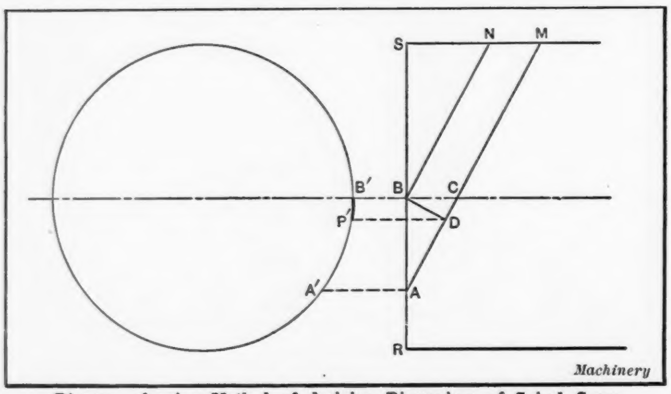


Diagram showing Method of deriving Dimensions of Spiral Gears

the specified distance between centers. To compensate for this condition it is necessary to have a little "shake" when trying the tooth calipers over a tooth. There is no definite allowance for this operation and the workmen generally guess as to what is about the correct allowance to make. However, it is possible to determine exactly what correction should be made and when this is done the operator can follow his instruction card as closely as he would do when cutting spur gears.

To avoid confusion the terms that are to be used in the following formulas may be defined as follows: The circular thickness of the tooth is its thickness measured on the circumference of the pitch circle. The axial thickness of the tooth is its thickness measured along a line on the pitch surface parallel to the axis of the gear. The normal thickness of the tooth is its shortest thickness on the pitch surface. In the accompanying diagram RS represents one end of the gear and the lines BN and AM are the sides of one tooth. In this diagram the distance AB represents the circular thickness of the tooth; the distance BC is the axial thickness of the tooth, and the distance BD is the normal thickness of the tooth. The angle ACB is the angle of the spiral and is equal to the angle ABD. It will be evident that the circular thickness is given by the following formula:

$$\text{Circular thickness} = AB = \frac{\pi R}{\text{No. of teeth}} \quad (1)$$

The normal thickness is given by the following formula:

$$\text{Normal thickness} = BD = AB \cos ACB \quad (2)$$

The axial thickness is given by the following formula:

$$\text{Axial thickness} = BC = \frac{BD}{\sin ACB} \quad (3)$$

It will be evident that in measuring the normal thickness it is necessary to measure across an arc of the pitch circle equal to the arc $P'B'$ shown in projection. This arc must be measured by its chord, which is the chord $P'B'$. There is also the height of the arc $P'B'$ to be considered. To find the chordal thickness corresponding to the normal thickness of the tooth measured on the pitch surface, it is first necessary to determine the chordal thickness corresponding to the circular thickness of the tooth. The value of the chordal circular thickness is given by the following formula:

Chordal circular thickness = sine (90 degrees ÷ number of teeth) pitch diameter.

Chordal normal thickness = chordal circular thickness × cosine ACB.

Chord $P'B'$ = cosine ACB × chordal normal thickness.

Let A = one-half of the angle subtended by the chord $P'B'$

$$\text{Then } \sin A = \frac{\text{Chord } P'B'}{\text{Pitch diameter}}$$

$$\text{Height of arc} = \text{Radius } (1 - \cos A)$$

The method of using these values of the dimensions of spiral gear teeth in cutting teeth of this type will best be explained by carrying through the steps in a problem of this kind:

Example

Let us consider a gear having eight teeth with a spiral angle of 48 degrees and a pitch diameter of 3 inches. The circular thickness of the teeth is found to be 0.5891 inch and the chordal circular thickness 0.5853 inch. The normal thickness of the teeth is 0.3942 inch and the chordal normal thickness is 0.3916 inch. The axial thickness of the teeth is 0.5303 inch. The chord of the arc measured across is 0.262 inch.

$$\sin A = \frac{0.262}{3.0} = 0.08733$$

A = 5 degrees 1 minute

Cosine A = 0.99617

Height of arc = R (1 — cos A) = 1.5 (1 — 0.99617) = 0.0057 inch

Chordal correction necessary = 0.0025 inch

* * *

The imports of machinery into Japan are steadily increasing. The total value of machinery imported during 1912 aggregated over $14,000,000, which is nearly double the value of the imports during 1910. Of these imports, Great Britain supplied slightly over 50 per cent, and Germany and the United States nearly 25 per cent each, but a small percentage being imported from other countries. The total imports of metal- and wood-working machinery were nearly $2,000,000 in 1912, Great Britain supplying over 55 per cent of this, the United States 25 per cent, and Germany about 15 per cent. Practically all of the textile machinery used in Japan comes from England. Germany has a large share of the water turbine trade, and the steam turbine business is about equally divided between the United States, England and Germany. Pumping machinery comes largely from England.

*Address: 224 Broadway, Providence, R. I.

TOOL STEEL FOR THE UNITED STATES NAVY*

PRESCRIBED SPECIFICATIONS AND TESTS RESULTING FROM PROTRACTED INVESTIGATION

Previous to 1909, each of the U. S. navy yards prepared requisitions for the purchase of tool steels for its own purposes. These requisitions either specified that proprietary material should be purchased or that the award of contract be based on information obtained by a test of some description on samples submitted by the bidders. By this method, there could be no uniformity in the specifications of the navy yards and in order to centralize purchasing and to standardize the tool steels, a tool steel board recommended that the Philadelphia Navy Yard be made the purchasing station. This action was taken in 1909 and at that time specifications were drawn up for one high-speed steel and three grades of carbon steel. The chemical composition required for the high-speed tool steel differed from that of any of the commercial brands, but the chemical composition of each grade of carbon steel corresponded to that of commercial tool steels. The three grades of carbon tool steel varied principally in their carbon content, in order to adapt them to the purposes for which such tool steels are generally used. The contracts were awarded to the lowest responsible bidder who was able to meet these specifications for tool steel of a chemical composition within the specified limits. The specifications required physical tests in addition to chemical analyses, as a part of the inspection, but these tests did not give decisive results and this proved conclusively that it was advisable to revise the existing specifications. This step was taken because these specifications did not provide a means of ascertaining the relative merits of the tool steels offered by the different bidders, or of learning whether there were other tool steels that were superior to those within the specified limits of chemical composition.

In order to overcome these objections, a set of specifications was finally drawn up which are presented in a later section of this article. These specifications require the bidders to submit samples of the tool steels which they offer for sale. The samples are manufactured into tools and subjected to physical tests devised to determine the relative merits of the different steels. The data obtained in this way constitute the basis for the award of contracts. In this set of specifications the chemical compositions are given the maximum and minimum limits, the purpose being to indicate to the bidder the kind of tool steel that is wanted, but the physical tests constitute the real basis for the award of contracts. The object of this provision is to introduce competition as to the quality of tool steels instead of simply having competition in price, to provide a means of learning something about the relative merits of the commercial tool steels, and to take advantage of the developments and progress made by the manufacturers in this industry. By this means, definite information can be obtained concerning the qualities of the different tool steels before the contracts are awarded for their purchase.

The study of tool steels which has been made possible by the adoption of this set of specifications is conducted under the direction of the engineer officer of the Philadelphia Navy Yard. The subject is divided into two general classes, one of which covers the high-speed or tungsten steels and the other the carbon tool steels.

Tungsten Steels

The limits of the chemical composition called for under the revised specifications were varied from those required by the original specifications in order to permit bidders to submit proposals on their commercial or standard tool steels, and the feature of a selective test was introduced. This selective test provides means for investigating the relative suitability of the different tool steels offered by bidders for the class of work for which the steel is required, and the recommendation for the award of contract is based on the information thus obtained. In order to obtain samples of tool steel for the selective test, the specifications require each bidder to furnish a sample bar of the tool steel which he offers. This bar is delivered to the engineer officer, under whose direction the selective tests are conducted. The heat-treatment of the tools, their chemical analysis, the condition of the physical test, and the computations necessary to determine the award of contract constitutes the selective test. A lathe tool selected for the physical test is kept cutting without lubricant until it fails by the sudden breaking down of the cutting edge, due to heating caused by friction of the chip. A record of the elapsed time of the run is made, which is the principal variable, other conditions being kept constant. After failure, each tool is reground, care being taken to remove the effect of the heat produced during the previous cut; the tool is then tested once more until it breaks down, as previously described. After the conclusion of this cut, the tool is reground and tested a third time.

During the test a voltmeter and ammeter are used to determine the power supplied to the motor which drove the test lathe. This is done in order to obtain a measure of the work done by the nose of the tool. The ammeter readings vary for the different tools, due principally to slight variations in depth of cut and cutting speed, which indicates that the work done by the different tools is not the same. In order to allow for this difference in computing the selective factor, a quantity was introduced called the "work value," which is the product of the mean elapsed time of run of all tools of a given sample and the mean watts required to drive the lathe minus the friction watts. The work value, therefore, is the watt-minutes of work done by the tool. The work values obtained from all of the samples of a given steel that were tested are then adjusted by the principles of least squares. The work value divided by the price per pound gives the "selective factor" for the test, the contract being awarded to the manufacturer of the steel having the highest selective factor.

In conducting the selective tests with tungsten tool steels, five tools made from the same sample bars are stamped with an index number which is assigned to each sample, and with consecutive numbers for the tools of each sample. The tools are hand-forged to the No. 30 lathe tool form of the Sellers system. The following day the tools are heat-treated. For this purpose, one oil furnace is maintained at a temperature of from 1600 to 1700 degrees F. and another furnace at from 2400 to 2450 degrees F. The cutting ends of the tools are preheated in the low temperature furnace and then transferred to the high temperature furnace. After the tools are removed from the heat-treating furnace, they are cooled by dipping the ends into oil. The oil is agitated by compressed air and is cooled to maintain it at as nearly an even temperature as possible. Oil is used for quenching because it is less noisy and less expensive than compressed air, and tests which have been made also appear to indicate that better results are obtained by using oil as a quenching medium. The tools are cooled in oil until they are black hot, when they are removed and placed on the cooling table. All the tools are tested on a single nickel-steel forging because the characteristics of nickel steel forgings vary. The depth of cut, feed, and cutting speed are kept constant throughout the selective test, thus making the cutting time the principal variable. All of the tools are tested to destruction after which they are reground and retested until each tool has been subjected to three tests. In regrinding it is found necessary to remove about 3/32 inch of the tool to get rid of the effects of heating.

Carbon Tool Steels

The information obtained from the selective tests conducted on samples of high-speed steel indicated that it was advisable to revise the requirements for carbon tool steels which were given by the original set of specifications, and a method of conducting selective tests, similar in character and purpose to those previously referred to, was adopted for use with this class of steels. Four classes of carbon tool steel were selected which varied principally in their carbon content. The specifications require the conditions of the selective test to be maintained as nearly constant as possible for each class of steel. The elapsed time of the run is the principal variable in the the test, the tools being operated until they break down. Milling cutters are used for the tests on steels of Classes 1 and 2

* Abstract of paper presented by Lewis H. Kenney before the Society of Naval Architects and Marine Engineers, November, 1912.

and the duration of the run consists of the total time that the cutters are operating, but it does not include the time required to return the milling machine table to the starting point and to set it for the next cut.

A cape chisel is used for the selective test on carbon tool steels of Class 3. In some of the early tests, trouble was experienced through breaking the shank of the hammer end of the chisel. This trouble has been overcome so far as the selective tests are concerned—and also in shop work—by heat-treating about ½ inch of the hammer end of the body with the shank and quenching the tool by dipping about ¾ inch into brine for a few seconds and then the entire tool. The cutting end is treated at the same temperature as the hammer end, and the temper of both ends is drawn by submerging the chisel in a molten lead bath at the desired temperature. In making these tests, it has been found that the heat-treatment does not extend back far from the cutting edge and there is only a short distance on the tool where the maximum cutting life can be obtained. If the chisel shows poor results on the first test, indicating that the temper has not been drawn sufficiently, the second test usually gives more satisfactory results, while the third test may show that the chisel is too soft.

A button-head rivet set is used for testing Class 4 of carbon steel. The set is heated to the desired temperature and quenched in brine, after which the temper is drawn in a lead bath. Each set is used to drive a certain number of hot rivets and an observation of its condition is made after the test. This test is not carried to destruction, however, as in the preceding tests and consequently does not yield decisive results.

The results of the tests of carbon steels of Classes 1, 2 and 3 vary considerably. As a result, it has not been found advisable to adjust these results by principles of least squares. After the tests have been completed, the data are gone over and those results which vary widely from the average are rejected. The selective factor for the different steels is then calculated and the contract awarded to the manufacturer whose steel shows the highest selective factor.

Each sample of carbon tool steel submitted for selective test is tested to determine the decalescent point in order that it may be hardened at a suitable temperature. In heat-treating, the temperature of the tools is raised to a point slightly above the decalescent point and they are then quenched in brine. After quenching, the temper is drawn in a lead bath, after which the cutting tools are ground ready for the selective test. The proportions of the milling cutters used for making the selective tests for carbon tool steel were adopted from an article by A. L. DeLeeuw which appeared in the 1911 transactions of the American Society of Mechanical Engineers. The distinctive feature of these milling cutters is the small size of the teeth, thus providing a large clearance for the chips. The cutter is operated at a speed of 370 revolutions per minute with a feed of 20 inches per minute and a depth of cut of 0.080 inch through the full travel of the milling machine table. The table is run back to the starting point and reset as often as necessary until the failure of the cutter occurs. The cutter is run without lubricant, in order to make the tests as severe as possible.

Specifications for Tungsten Tool Steel

1. *Class* 1.—Lathe and planer tools, milling-machine tools, and in general all tools for which high-speed steel is used.

Specifications for Carbon Steel

2. *Class* 1.—Lathe and planer tools, and tools requiring keen cutting edge combined with great hardness, for finishing shrinkage dimensions on nickel-steel gun forgings, drills, taps, reamers, and screw-cutting dies.

3. *Class* 2.—Milling cutters, mandrels, trimmer dies, threading dies, and general machine-shop tools requiring a keen cutting edge combined with hardness.

4. *Class* 3.—Pneumatic chisels, punches, shear blades, etc., and in general tools requiring hard surface with considerable tenacity.

5. *Class* 4.—Rivet sets, hammers, cupping tools, smith tools, hot drop-forge dies, etc., and in general tools which require great toughness combined with the necessary hardness.

CHEMICAL COMPOSITION

Tungsten Tool Steel	Class 1, Per Cent Limit	
	Maximum	Minimum
Carbon	0.75	0.55
Chromium	5.00	2.50
Manganese	0.30	0.05
Phosphorus	0.015	....
Silicon	0.30	....
Sulphur	0.02	....
Tungsten	20.00	16.00
Vanadium	1.50	0.35
Iron	*	*

Machinery

* Remainder

Carbon Tool Steel	Class 1, Per Cent Limit		Class 2, Per Cent Limit		Class 3, Per Cent Limit		Class 4, Per Cent Limit	
	Maxi-Mum	Mini-mum	Maxi-mum	Mini-Mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum
Carbon	1.25	1.15	1.15	1.05	0.95	0.85	0.85	0.75
Chromium	†	†	†	†	†	†	†	†
Manganese	0.35	0.15	0.35	0.15	0.35	0.15	0.35	0.15
Phosphorus	0.015	.....	0.015	.....	0.02	....	0.02	.....
Silicon	0.40	0.10	0.40	0.10	0.40	0.10	0.40	0.10
Sulphur	0.02	.....	0.02	.....	0.02	.....	0.025	.....
Vanadium	†	†	†	†	†	†	†	†
Iron	*	*	*	*	*	*	*	*

Machinery

*Remainder † Optional

Physical Tests of Tungsten Tool Steel

6. Class 1.—The sample bar will be forged into five tools, treated and ground to the No. 30 form of the Sellers system of lathe tool forms. Each tool will be tested on a nickel-steel forging of about 100,000 pounds tensile strength, with a cut ¼ inch deep, 1/16 inch feed, and a cutting speed of 50 feet per minute. Each tool will be twice reground and retested. A record will be made of the length of time each tool cuts without a lubricant or cutting compound before it is ruined.

Physical Tests of Carbon Tool Steel

7. *Class* 1.—Five 7/16-inch diameter, 4-tooth facing mills will be made from the sample bar and tested on a piece of ⅝-inch ship's plate without lubricant. Each mill will be run until it is so dull that it breaks either in the teeth or in the shank. The depth of cut will be 0.08 inch, the revolutions per minute of the mill will be 370, and the feed of material 20 inches per minute. A record will be made of the length of time each mill operates.

8. *Class* 2.—Same tests as *Class* 1.

9. *Class* 3.—Five ½-inch pneumatic chisels will be made from the sample bar. Each chisel will be tested on a nickel-steel plate with a cut 1/16 inch deep.

A record will be made of the distance each chisel cuts with a lubricant before it is ruined.

10. *Class* 4.—Two ½-inch rivet sets will be made from the sample bar. A record will be made of the condition of the sets after a certain number of rivets have been driven.

11. *Modification of Tests.*—Any or all of the above tests may be modified at the discretion of the engineer officer.

General

12. *Method of Manufacture.*—The tool steels shall be made in either the electric or crucible furnace. The bars must be forged or rolled accurately to the dimensions specified, free from seams, checks, and other physical defects and of homogeneous composition. The tungsten tool steels shall be delivered unannealed, unless otherwise specified, and the carbon tool steels shall be delivered annealed unless otherwise specified. The bars shall be delivered in commercial lengths and short pieces will not be accepted unless so specified.

13. *Stamps on Material.*—Each bar or piece of tool steel, whether sample bar for "selective test," "acceptance test," or material delivered under contract, shall be stamped with the manufacturer's name, his trade name and temper index, and in addition identification stamps of the kind and class of tool steel as given in these specifications. The tungsten tool steel,

Class 1, shall be stamped T-1, and the carbon tool steels, Classes 1, 2, 3, and 4: C-1, C-2, C-3, and C-4; the letters to be about 3/16 inch high. If the bars are longer than about 4 feet, the above stamps should be placed at intervals of about 3 feet along the bar.

14. *Acceptance Test.*—Sample bars for "acceptance test" will be taken from the material delivered under contract to the general storekeeper, Navy Yard, Philadelphia, Pa., or if the material is inspected at the place of manufacture, the inspector will forward sample bars of the dimensions called for to the storekeeper, who will forward them to the engineer officer for him to arrange the tests indicated by these specifications and recommend the acceptance or rejection of the material. If the material does not prove to be equivalent to the sample bar furnished with proposal this will be considered sufficient cause for rejection. The contractor shall replace the shipment within two weeks, if practicable, after the receipt of notice of rejection. The sample bars used for this test will be credited the contractor if the material under test is accepted.

15. *Defective Material.*—If material, when being manufactured into tools, develops physical defects which could not be detected by inspection, such as "cracks," "pipes," etc., the manufacturer of this steel shall replace, without cost to the government, such defective material.

Proposals

16. *Reservation and Alternate Proposals.*—The right is reserved to reject any or all proposals.

Bidders may submit proposals on tool steel which differs from the composition and method of manufacture specified, provided this is clearly stated in their proposal, and provided they furnish the engineer officer with a statement of the exact chemical composition and method of manufacture of the tool steel. This information will be considered confidential by the engineer officer if the bidder requests it. The tool steel will be tested if, in the opinion of the engineer officer, it is considered suitable for the purpose intended.

17. The engineer officer will, after the prescribed tests have been made, recommend the award of contract for the steel or steels which, in his opinion, it is to the best interest of the government to purchase, due consideration being given to the cost of the material. The relation of the tests and the price of the material will be the basis for selection.

18. *Selective Test.*—Each bidder shall furnish with his proposal a sample bar of tool steel stamped as called for under heading "Stamps on Material" for the "selective test." The relation of the results obtained from the tests conducted as provided for under the heading "Physical Tests" and the price of the material determine the selective factor. The dimensions of the sample bars shall be as follows:

Tungsten Tool Steel

Class 1.—¾ by 1½ inch by 5 feet long.

Carbon Tool Steel

Class 1.—⅝-inch diameter rod, 2 feet long.
Class 2. ⅝-inch diameter rod, 2 feet long.
Class 3.—¾-inch octagon rod, 5 feet long.
Class 4.—2-inch diameter rod, 2 feet long.

19. *Treatment of Samples.*—Each bidder will state in his proposal, if he considers it necessary to do so, the treatment to which the material must be subjected in order to get, in his opinion, the best results.

20. *Delivery of Sample Bars.*—All sample bars stamped as called for under the heading "Stamps on Material" must be delivered to the general storekeeper, Building No. 4, Navy Yard, Philadelphia, Pa., prior to the time fixed for opening of proposals. Sample bars delivered late will not be received. Failure to comply with the above requirements will eliminate the proposal from consideration. All sample bars will be delivered by the general storekeeper to the engineer officer for the "selective tests."

* * *

BROACHING PIVOT HOLES IN SCALE PARTS

The J. N. Lapointe Co., of New London, Conn., recently made a fixture for use on one of its broaching machines whereby the seats for the knife-edge pivots used in scale work may be broached two at a time. Fig. 1 shows the machine with the work and fixtures, while Fig. 2 is a close-range view of the fixture, broaches and work. The brass castings which must be broached are of different lengths. The broached holes must be at exact distances apart; they are first jig-drilled to the body size, and then by means of a double broaching head, the two broaches are pulled through the drilled holes, finishing them to shape.

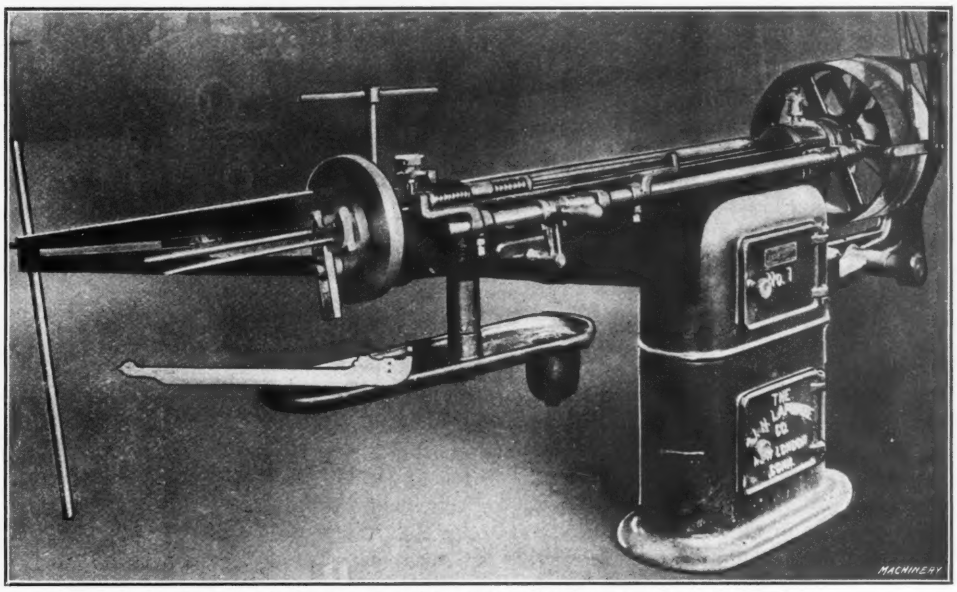


Fig. 1. J. N. Lapointe Broaching Machine fitted for broaching Scale Parts

Referring to Fig. 2, it will be seen that the fixture consists of a supporting plate which is slotted to receive the stud upon which the rear end of the broached piece rests. This stud is adjustable in its position to adapt it to the different lengths of castings which are to be broached. Upon the drip pan of the broaching machine may be seen one of the largest as well as one of the smallest pieces which are finished in this way. While being broached the piece is clamped against the faceplate, and before commencing the stroke the two broaches are slipped through the drilled holes and clamped to the broaching head; then both broaching cuts are made at once. The old way of finishing these seats for the pivots was to file them, and it will be appreciated that broaching produces better work in less time.

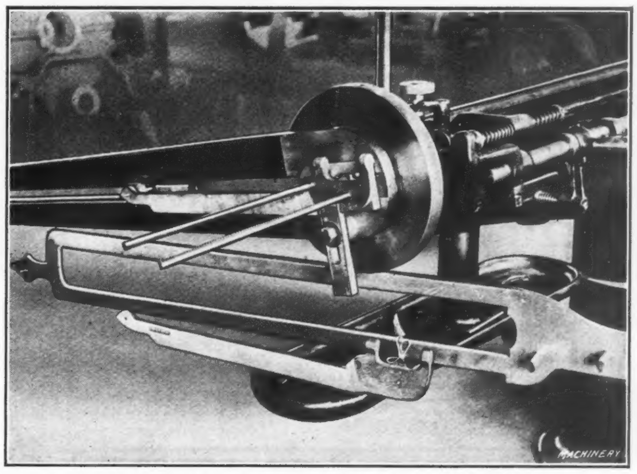


Fig. 2. Close-range View of Fixture and Work

C. L. L.

AN ANALYSIS OF CRANKSHAFT STRESSES

DETERMINATION OF STRESSES IN TWO- AND THREE-BEARING, FOUR-CYLINDER CRANKSHAFTS

BY K. W. NAJDER*

One of the most expensive and important parts of the automobile motor is the crankshaft. The machine work on this part must be extremely accurate and a high grade of material should be used as it is subjected to heavy strains.

The determination of crankshaft stresses can be done analytically or graphically, and it is a good practice to first use the analytical method and then check the results graphically. An adequate maximum pressure in the cylinder should be assumed, which should be taken as high as 20 to 25 atmospheres per square inch. All journals and crankpins should be dimensioned to withstand the surface pressure and friction in the bearings, and a liberal factor of safety allowed.

The material used is medium carbon steel with a tensile strength of 90,000 pounds per square inch, elastic limit 70,000 pounds, and an elongation of about 15 per cent in 2 inches. A far better material than medium carbon steel is a 3½ per cent nickel steel which has a tensile strength of about 120,000 pounds per square inch, elastic limit of 90,000 pounds and an elongation of about 16 per cent in 2 inches. Chrome-vanadium and chrome-nickel steels are very hard to machine; therefore these materials are very seldom used for crankshafts.

The allowable pressure on the journals and crankpins should not exceed 1000 pounds per square inch. One of the chief requirements of a crankshaft is stiffness, which depends upon the coefficient of elasticity of the material, and the value of this coefficient should be from 30,000,000 to 40,000,000. The arms of the crankshaft should be made of suitable thickness to give the required strength and stiffness, and here the bending stresses are of prime importance. The bending moment varies directly as the distance from the bearing, and the resistance to bending is directly proportional to the square of the thickness of the arms. However good a designer's judgment may be, and no matter what empirical formulas he has at his disposal, he must seek confirmation of his guesses in figures. This is absolutely necessary when the horsepower of the motor rises above 40, and in racing cars where the horsepower may vary anywhere from 70 to 200, calculations must be relied on in preference to judgment and empirical formulas. In the following, two problems will be completely worked out to illustrate the method of determining crankshaft stresses.

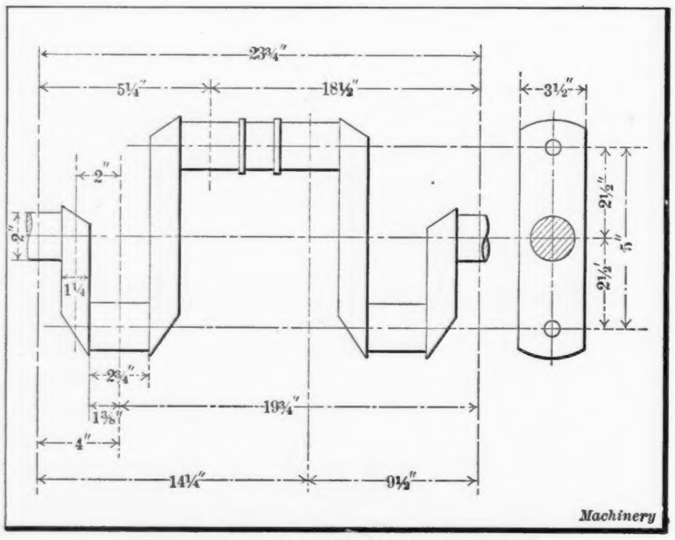


Fig. 1. Four-cylinder, Two-bearing Crankshaft

Four-cylinder Two-bearing Crankshaft

It will be assumed that the motor has a bore of 4 inches and a stroke of 5 inches, and that the maximum explosive pressure is 20 atmospheres per square inch. The maximum pressure on the piston is:

$$P_{max} = \frac{D^2 \pi}{4} \times 20 = 250 \text{ atmospheres} = 3750 \text{ pounds.}$$

*Address: 63 Franklin Blvd., Pontiac, Mich.

The connecting-rod pressure $\frac{P_{max}}{\cos\beta}$ is composed of two components, a tangential force T, and a radial force R. (Hütte).

Let $\alpha = 30$ degrees and $\beta = 7$ degrees.

$$T = \frac{P_{max}}{\cos\beta} \sin(\alpha + \beta)$$

$$= \frac{3750}{0.9925} \times 0.6018$$

$= 2270$ pounds;

$$R = \frac{P_{max}}{\cos\beta} \cos(\alpha + \beta)$$

$$= \frac{3750}{0.9925} \times 0.7986$$

$= 3017$ pounds.

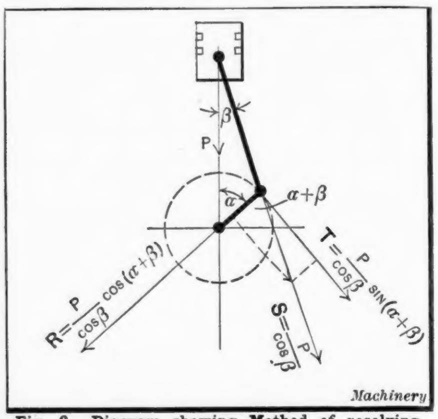


Fig. 2. Diagram showing Method of resolving Connecting-rod Thrust

Each of these forces produces pressures on the crankshaft. The greatest pressures will be on the left crankshaft arm when cylinder No. 1 explodes.

Pressure due to tangential force $A_t = \frac{T \times 19\frac{3}{4}}{23\frac{3}{4}} = \frac{2270 \times 19\frac{3}{4}}{23\frac{3}{4}}$ $= 1880$ pounds;

Pressure due to radial force $A_r = \frac{R \times 19\frac{3}{4}}{23\frac{3}{4}} = \frac{3017 \times 19\frac{3}{4}}{23\frac{3}{4}}$ $= 2500$ pounds.

The maximum pressure is:

$$A_{max} = \sqrt{A_t^2 + A_r^2} = \sqrt{1880^2 + 2500^2} = 3125 \text{ pounds.}$$

The maximum pressure on the pin is:

$$\frac{3125}{2 \times 2\frac{3}{4}} = 568 \text{ pounds.}$$

The maximum bending moment on the extreme end of pin is:

$$M_c = 3125 \times 1\tfrac{3}{8} = 4300 \text{ inch-pounds;}$$

The section modulus of the pin is:

$$\frac{D^3 \pi}{32} = \frac{2^3 \times 3.14}{32} = 0.7856;$$

$$\text{Stress } S = \frac{4300}{0.7856} = 5470 \text{ pounds.}$$

Bending Moment of the Left Arm

M_1 = moment due to radial force $= A_r \times 2 = 2500 \times 2 = 5000$ inch-pounds;

Section modulus of arm $= \frac{Ch^2}{6} = \frac{3.5 \times 1.25^2}{6} = 0.90$;

S_1 = stress due to radial moment $= \frac{5000}{0.90} = 5555$ pounds;

M_2 = moment due to tangential force $= A_t \times 2\frac{1}{2} = 1880 \times 2\frac{1}{2}$ $= 4700$ inch-pounds;

Section modulus $= \frac{hC^2}{6} = \frac{1.25 \times 3.5^2}{6} = 2.55$;

S_2 = stress due to tangential moment $= \frac{4700}{2.55} = 1840$ pounds;

M_t = torsion moment $= A_t \times 2 = 1880 \times 2 = 3760$ inch-pounds;

Polar section modulus $= 2/9\ Ch^2 = 2/9 \times 3\frac{1}{2} \times 1.25^2 = 1.215$;

S_t = stress due to torsion moment $= \frac{3760}{1.215} = 3090$ pounds.

The resultant of the tangential and radial bending moments is:

$$M_c = \sqrt{M_1^2 + M_2^2} = \sqrt{5000^2 + 4700^2} = 6860 \text{ inch-pounds.}$$

The resultant of the stresses due to tangential and radial bending moments is:

$$S_c = \sqrt{S_1^2 + S_2^2} = \sqrt{5555^2 + 1840^2} = 5850 \text{ pounds.}$$

The resultant of the bending and torsion moments is:

$$M_r = \tfrac{3}{8}\, M_c + \tfrac{5}{8}\, \sqrt{M^2_c + M^2_t} = \tfrac{3}{8} \times 6860 + \tfrac{5}{8}\, \sqrt{6860^2 + 3760^2}$$
$$= 7450 \text{ inch-pounds.}$$

The resultant of the stresses due to bending and torsion moments is:

$$S_r = \tfrac{3}{8}\, S_c + \tfrac{5}{8}\, \sqrt{S^2_c + S^2_t} = \tfrac{3}{8} \times 5850 + \tfrac{5}{8}\, \sqrt{5850^2 + 3090^2} =$$
$$6330 \text{ pounds.}$$

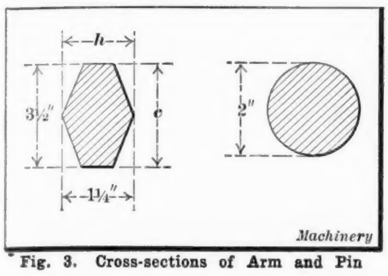


Fig. 3. Cross-sections of Arm and Pin

The maximum bending moment on the left journal is:

$M = A_{max} \times 4 = 3125 \times 4 = 12{,}500$ inch-pounds;

Section modulus $= \dfrac{D^3\,\pi}{32} = \dfrac{2^3 \times 3.14}{32} = 0.7856$;

$$S = \text{stress due to maximum bending moment} = \frac{12{,}500}{0.7856} =$$
15,900 pounds.

Stresses on Center Journals

The maximum stresses on both center journals will take place when cylinder No. 2 or No. 3 explodes.

The moment of the left center journal is approximately:

$$M = \frac{3750 \times 5\tfrac{1}{4} \times 18\tfrac{1}{2}}{23\tfrac{3}{4}} = 15{,}600 \text{ inch-pounds;}$$

Section modulus = 0.7856;

$$\text{Stress } S = \frac{15{,}600}{0.7856} = 19{,}900 \text{ pounds.}$$

The moment of the right center journal is:

$$M = \frac{3750 \times 14\tfrac{1}{4} \times 9\tfrac{1}{2}}{23\tfrac{3}{4}} = 21{,}300 \text{ inch-pounds;}$$

Section modulus = 0.7856;

$$\text{Stress } S = \frac{21{,}300}{0.7856} = 27{,}000 \text{ pounds.}$$

The bending moments and torsions of the center arms are figured in a similar manner to that used in connection with the left arm.

Pressure on the Pin

We have found $A_{max} = 3125$ pounds.

$$\text{The maximum pressure on the pin is } \frac{3125}{2 \times 2\tfrac{3}{4}} = 568 \text{ pounds.}$$

The circumferential velocity of the pin is:

$$V = \frac{2}{12} \times \frac{\pi \times 1400}{60} = 12.21 \text{ feet per second.}$$

The motor runs at 1400 revolutions per minute and the coefficient of friction $\mu = 0.05$ (Hütte and Güldner).

The work done by friction is $568 \times 0.05 \times 12.21 = 347$ foot-pounds per second.

It will be remembered that one horsepower equals 550 foot-pounds per second; consequently, the lost power due to the friction of the pin is:

$$\frac{347}{550} = 0.63 \text{ horsepower.}$$

The deflection of the crankshaft is obtained from the formula:

$$\text{Deflection} = \frac{P\,l^3}{48\,E\,I}$$

where

P = maximum explosive pressure;
l = length of crankshaft;
E = coefficient of elasticity = about 30,000,000 to 40,000,000;
I = moment of inertia.

Four-cylinder Three-bearing Crankshaft

We will now consider a four-cylinder, three-bearing crankshaft on a motor which has a bore of 4¼ inches, a stroke of 4½ inches and a flywheel weighing 70 pounds.

The forces on the crankshaft are:

Connecting-rod pressures = P_0, P_0', P_1' and P_1;
Weight of flywheel = P_2;
Reactions on bearings = T_0, T_1 and T_2;
Bending moments at bearings = M_0, M_1 and M_2.

Clapeyron's formula for a beam supported at three points is:

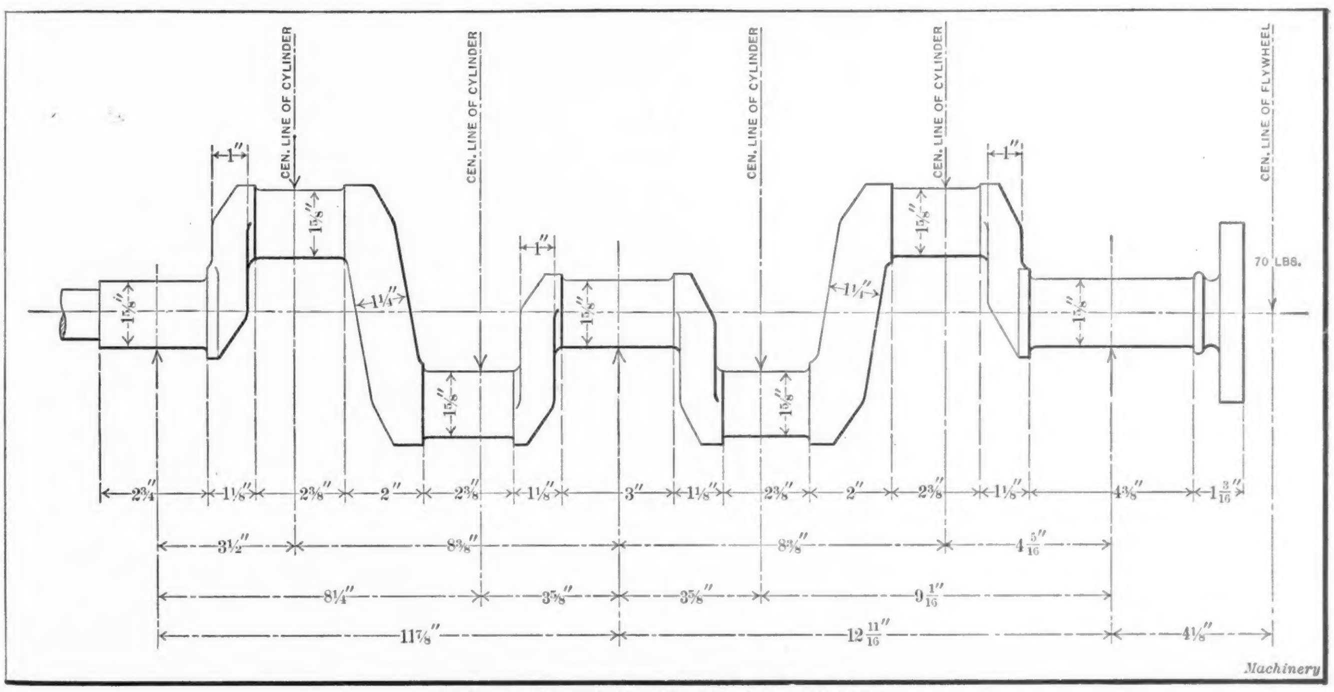


Fig. 4. Four-cylinder, Three-bearing Crankshaft

$$- M_0\, l_0 - 2\, M_1 (l_0 + l_1) - M_2\, l_1 = \frac{P_0 a_0 (l_0^2 - a_0^2)}{l_0} + \frac{P_0' a'_0 (l_0^2 - a'^2_0)}{l_0}$$
$$+ \frac{P_1\, a_1 (l^2_1 - a^2_1)}{l_1} + \frac{P_1' a_1' \,(l_1^2 - a'^2_1)}{l_1}. \quad \text{(Hütte and Heller).}$$

To start with, we will put in the above formula:

$M_0 = 0$, $M_2 = P_2 l_2 = 70 \times 4\tfrac{1}{8} = 288$ inch-pounds.

To be safe, we also assume that there are explosions in two cylinders at a time.

$$P_0 = P_1 = \frac{D^2\,\pi}{4} \times 25 = 354 \text{ atmospheres} = 5320 \text{ pounds;}$$

$$P'_0 = P'_1 = \frac{D^2\,\pi}{4} \times 1.6 = 360 \text{ pounds.}$$

From the crankshaft drawing, Fig. 4, we obtain:

$a_0 = 3\frac{1}{2}$ inches; $l_0 = 11\frac{7}{8}$ inches;
$a'_0 = 8\frac{1}{4}$ inches; $l_2 = 4\frac{1}{8}$ inches;
$a'_1 = 9\frac{1}{16}$ inches; $l_1 = 12\frac{11}{16}$ inches;
$a_1 = 4\frac{5}{16}$ inches; $P_2 = 70$ pounds = flywheel weight.

Then:

$$-2M_1\left(11\tfrac{7}{8} + 12\tfrac{11}{16}\right) - 288 \times 12\tfrac{11}{16} = \frac{5320 \times 3\frac{1}{2}\left(11\frac{7}{8}^2 - 3\frac{1}{2}^2\right)}{11\frac{7}{8}}$$

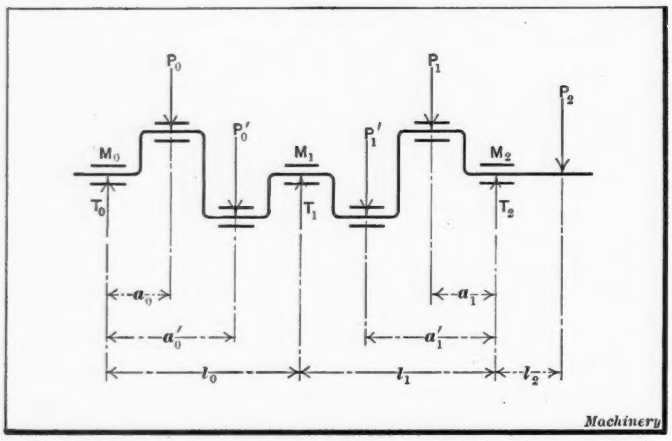


Fig. 5. Diagram showing Moments, Pressures and Reactions in Fig. 4

$$+\frac{360 \times 8\frac{1}{4}\left(11\frac{7}{8}^2 - 8\frac{1}{4}^2\right)}{11\frac{7}{8}} + \frac{5320 \times 4\frac{5}{16}\left(12\frac{11}{16}^2 - 4\frac{5}{16}^2\right)}{12\frac{11}{16}} + \frac{360 \times 9\frac{1}{16}\left(12\frac{11}{16}^2 - 9\frac{1}{16}^2\right)}{12\frac{11}{16}}$$

$$-M_1\,49.125 - 3654 = \frac{18{,}580\,(141 - 12.25)}{11\frac{7}{8}} + \frac{2970\,(141 - 68)}{11\frac{7}{8}}$$

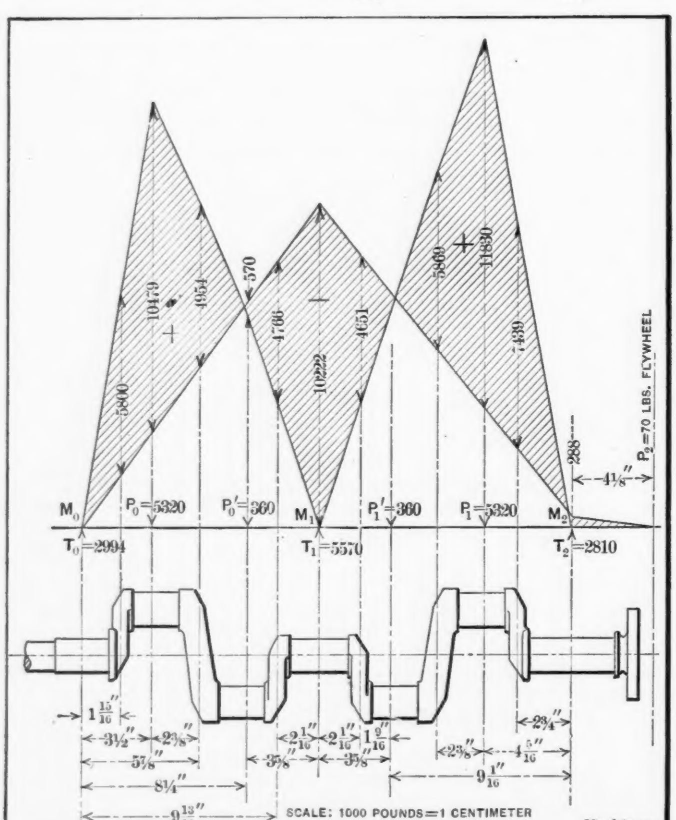


Fig. 6. Diagram of Bending Moments of Crankshaft when Cylinders No. 1 and No. 4 explode

$$+\frac{22{,}942\,(161.2-18.5)}{12\frac{11}{16}} + \frac{3262\,5\,(161.2-82)}{12\frac{11}{16}} - M_1\,49.125 - 3654$$

$$= \frac{2{,}614{,}135}{11\frac{7}{8}} + \frac{3{,}532{,}213}{12\frac{11}{16}} = 498{,}538$$

$$-M_1 = \frac{502{,}192}{49.125} = 10{,}222$$

$$M_1 = -10.222 \text{ inch-pounds.}$$

Reactions T are a combination of part A to the right of any particular bearing, and part B to the left of this bearing. (Hütte.)

$T_0 = A_0 + B_0$;
$T_1 = A_1 + B_1$;
$T_2 = A_2 + B_2$.

Clapeyron's formula is:

$$A_0 = \frac{M_1 - M_0}{l_0} + \frac{P_0\,(l_0 - a_0)}{l_0} + \frac{P'_0\,(l_0 - a'_0)}{l_0};$$

$$B_0 = 0; \qquad 0{,}786$$

$$T_0 = \frac{M_1 - M_0}{l_0} + \frac{P_0\,(l_0 - a_0)}{l_0} + \frac{P_0'\,(l_0 - a_0')}{l_0};$$

$$A_1 = \frac{M_2 - M_1}{l_1} + \frac{P_1\,a_1}{l_1} + \frac{P'_1\,a'_1}{l_1};$$

$$B_1 = \frac{M_0 - M_1}{l_0} + \frac{P_0\,a_0}{l_0} + \frac{P'_0 a'_0}{l_0};$$

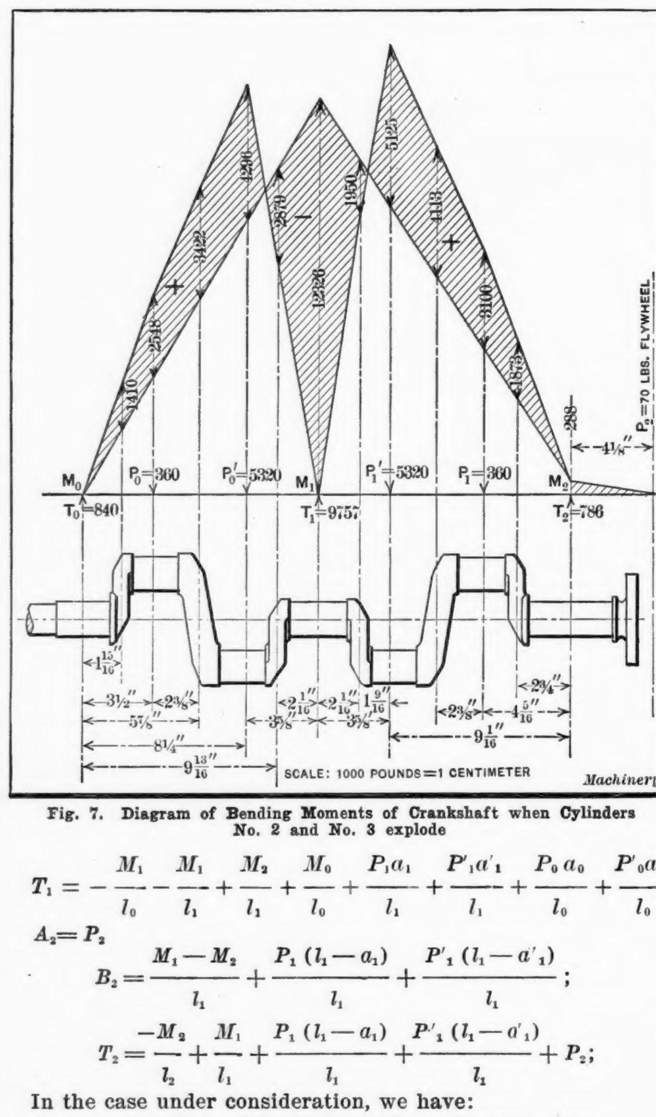


Fig. 7. Diagram of Bending Moments of Crankshaft when Cylinders No. 2 and No. 3 explode

$$T_1 = -\frac{M_1}{l_0} - \frac{M_1}{l_1} + \frac{M_2}{l_1} + \frac{M_0}{l_0} + \frac{P_1 a_1}{l_1} + \frac{P'_1 a'_1}{l_1} + \frac{P_0\,a_0}{l_0} + \frac{P'_0 a'_0}{l_0}$$

$$A_2 = P_2$$

$$B_2 = \frac{M_1 - M_2}{l_1} + \frac{P_1\,(l_1 - a_1)}{l_1} + \frac{P'_1\,(l_1 - a'_1)}{l_1};$$

$$T_2 = \frac{-M_2}{l_2} + \frac{M_1}{l_1} + \frac{P_1\,(l_1 - a_1)}{l_1} + \frac{P'_1\,(l_1 - a'_1)}{l_1} + P_2;$$

In the case under consideration, we have:

$$T_0 = -\frac{10{,}222}{11\frac{7}{8}} + \frac{5320\left(11\frac{7}{8} - 3\frac{1}{2}\right)}{11\frac{7}{8}} + \frac{360\left(11\frac{7}{8} - 8\frac{1}{4}\right)}{11\frac{7}{8}} =$$

2994 pounds;

$$T_1 = \frac{10{,}222}{11\frac{7}{8}} + \frac{10{,}222}{12\frac{11}{16}} + \frac{288}{12\frac{11}{16}} + \frac{5320 \times 4\frac{5}{16}}{12\frac{11}{16}} + \frac{360 \times 9\frac{1}{16}}{12\frac{11}{16}} +$$

$$\frac{5320 \times 3\frac{1}{2}}{11\frac{7}{8}} + \frac{360 \times 8\frac{1}{4}}{11\frac{7}{8}} = 5570 \text{ pounds;}$$

$$T_2 = -\frac{288}{4\frac{1}{8}} - \frac{10{,}222}{12\frac{11}{16}} + \frac{5320\left(12\frac{11}{16} - 4\frac{5}{16}\right)}{12\frac{11}{16}} +$$

$$\frac{360\left(12\frac{11}{16} - 9\frac{1}{16}\right)}{12\frac{11}{16}} + 70 = 2810 \text{ pounds.}$$

Then we have:

$T_0 = 2994$ pounds, $T_1 = 5570$ pounds, $T_2 = 2810$ pounds.

Crankshaft Turned Forward 180 Degrees

In the same way, we can find the moments when the crankshaft is turned forward 180 degrees.

Then:

$P_0 = P_1 = 360$ pounds;

$P'_0 = P'_1 = 5320$ pounds.

As in the preceding case, we assume $M_0 = 0$, $M_2 = 288$ inch-pounds.

By Clapeyron's formula:

$$-2M_1 (11\tfrac{7}{8} + 12\tfrac{11}{16}) - 288 \times 12\tfrac{11}{16} = \frac{360 \times 3\tfrac{1}{2} (11\tfrac{7}{8}^2 - 3\tfrac{1}{2}^2)}{11\tfrac{7}{8}} +$$

$$\frac{5320 \times 8\tfrac{1}{4} (11\tfrac{7}{8}^2 - 8\tfrac{1}{4}^2)}{11\tfrac{7}{8}} + \frac{360 \times 4\tfrac{5}{16} (12\tfrac{11}{16}^2 - 4\tfrac{5}{16}^2)}{12\tfrac{11}{16}} +$$

$$\frac{5320 \times 9\tfrac{1}{16} (12\tfrac{11}{16}^2 - 9\tfrac{1}{16}^2)}{12\tfrac{11}{16}} = 12{,}326;$$

$M_1 = -12{,}326$ inch-pounds;

$$T_0 = -\frac{12{,}326}{11\tfrac{7}{8}} + \frac{360 (11\tfrac{7}{8} - 3\tfrac{1}{2})}{11\tfrac{7}{8}} + \frac{5320 (11\tfrac{7}{8} - 8\tfrac{1}{4})}{11\tfrac{7}{8}} = 840 \text{ pounds};$$

$$T_1 = \frac{12{,}326}{11\tfrac{7}{8}} + \frac{12{,}326}{12\tfrac{11}{16}} + \frac{288}{12\tfrac{11}{16}} + \frac{360 \times 4\tfrac{5}{16}}{12\tfrac{11}{16}} + \frac{5320 \times 9\tfrac{1}{16}}{12\tfrac{11}{16}} +$$

$$\frac{360 \times 3\tfrac{1}{2}}{11\tfrac{7}{8}} + \frac{5320 \times 8\tfrac{1}{4}}{11\tfrac{7}{8}} = 9757 \text{ pounds};$$

$$T_2 = -\frac{288}{4\tfrac{1}{8}} - \frac{12{,}326}{12\tfrac{11}{16}} + \frac{360 (12\tfrac{11}{16} - 4\tfrac{5}{16})}{12\tfrac{11}{16}} + \frac{5320 (12\tfrac{11}{16} - 9\tfrac{1}{16})}{12\tfrac{11}{16}} +$$

$70 = 786$ pounds;

$T_0 = 840$ pounds, $T_1 = 9757$ pounds, $T_2 = 786$ pounds.

Knowing the reactions T_0, T_1 and T_2, the bending moments at any point of the crankshaft can be easily figured out. We see that the maximum bending moment of the center journal will occur when there are explosions in the second and third cylinder; this moment is 12,326 inch-pounds. The maximum bending moment of the arms takes place when the first and fourth cylinders explode, and is equal to 7439 inch-pounds, which is the bending moment of the right arm. The combined bending moments and torsions are figured in a similar way to that followed with the four-cylinder, two-bearing crankshaft in the first example. From this discussion, we see what a small influence the flywheel has upon the crankshaft.

* * *

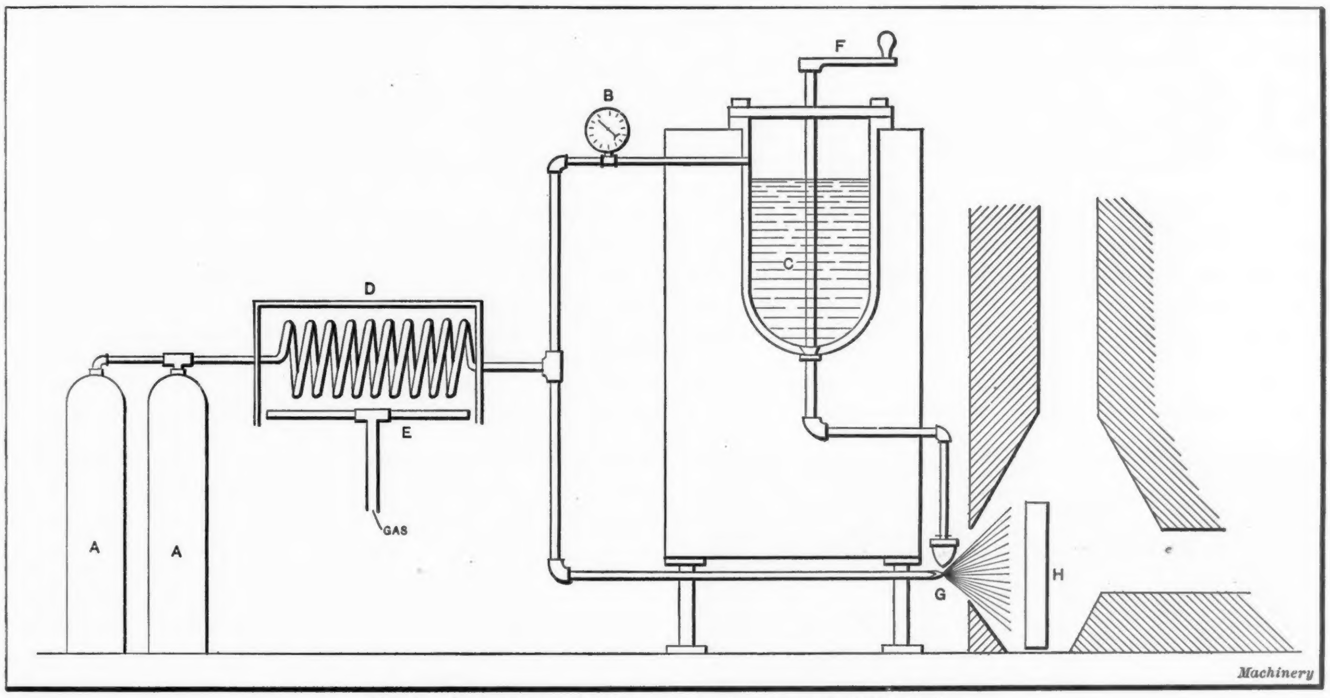
Electrical baths will be one of the features of a new club house of the Association of Employes of the New York Edison Co. which has recently been opened in New York City.

THE SCHOOP SYSTEM OF METAL PLATING*

The process of plating or depositing metal in a layer of any required thickness, invented and perfected by M. Schoop, has finally come into practical use. The principle was described before the French Academy of Sciences in 1910. It consists in projecting molten and atomized metal upon the surfaces to be plated.

Like most inventions the Schoop process resulted from the observation of a very simple phenomenon. M. Schoop, who is a Swiss engineer, well known by his works on electro-chemistry and accumulators, was one day watching his children shooting against a wall with an air gun. He noticed that the shot deposited upon the wall a very adherent coat of lead. From this he conceived the idea of metal plating by projection which he has finally worked out.

The experiments made since 1910 have shown the best methods of giving a plating of the required composition and appearance with any given metal. The inventor uses two modes of operation: one using the metal in fusion and the other as a powder. The apparatus employed in using molten metal is shown herewith. At *A* are reservoirs of gas or air under pressure; *B* is a pressure gage; *C* is the crucible of molten metal; *D* is a heater with gas burner *E*; *F* a handle controlling the valve which allows the escape of the metal; *G* is an atomizer; and *H* the object to be plated. With this arrangement the pressure of the flowing metal and that of the current of air or gas producing the atomization are equal, and on account of the heating the gas arrives at the surface of the metal warm, notwithstanding its expansion.



Showing General Principle of the Schoop Apparatus for Metal Plating

The installation is usually stationary, but for objects which cannot be moved a portable arrangement is used. In this case the metal is first reduced to a very fine powder by means of the stationary apparatus. The powder is placed in a strong vessel, in which it can be subjected to pressure: a flexible tube serves as a means of conveying the spray to the different parts of an object. Connected with the discharge tube is a gas torch, and as the fine powder strikes the flame it is converted into a metallic cloud. It is found that a coating of any desired thickness may be applied by this method, and it is being extensively used in France for plating with zinc, lead and copper.

* * *

The exports of automobiles from France amounted, in 1912, to about $40,000,000, an increase of about 25 per cent over the exports during 1911. The imports of automobiles into France do not exceed $2,500,000.

* See also "New Method of Metal Coating," April, 1911.

AUTOMOBILE MANUFACTURING METHODS*

INTERESTING DRILLING, BORING AND MILLING JIGS AND FIXTURES USED IN PRODUCING THE REO MOTOR CAR

BY DOUGLAS T. HAMILTON†

The Reo Motor Car Co., Lansing, Mich., builds only one type of chassis on which different bodies are mounted, and hence gives its entire attention to the production of parts which, to a large extent, are standard. This makes it necessary for this company to devise jigs and fixtures to handle the work in the most efficient manner, owing to the large number of interchangeable parts made. In the following, a few of the most interesting operations, as well as the jigs and fixtures used in manufacturing certain parts will be illustrated and described.

Machining Brake Supports

One of the many interesting operations is the machining of brake supports, a detail view of which is shown in Fig. 2. These supports are made from malleable iron castings and are machined practically complete in Baker vertical drilling machines. Fig. 1 shows the row of four vertical drilling machines used for performing the boring, reaming and facing operations—one man attending to two machines. In the first operation the holes *A* and *B* are bored and reamed, and the top face *C* and inside shoulder *D* are rough-faced. The boring is accomplished in the first machine (see Fig. 1) with an inserted high-speed steel boring tool which rough-bores the diameter *A* to 2.558 inches. The casting is then removed and placed in the jig under the second machine, where it is finish-reamed to 2.5655 inch diameter. The partly machined brake support is now passed to the next operator who inverts it and places it in the jig under the third machine in the row. Here the largest diameter *E* is bored to 3.960 inches, and at the same time the end *F* is rough-faced. The next operation is finish-reaming, which is accomplished in the last machine in the row. Here, in addition to reaming the hole to 3.990 inches, the top face and the inner shoulder are faced, bringing the casting to the correct depth and length. This finishes the boring and reaming operations on the brake support.

The brake supports are now taken to the vertical drilling machine shown in Fig. 3, where the hub end is machined, as

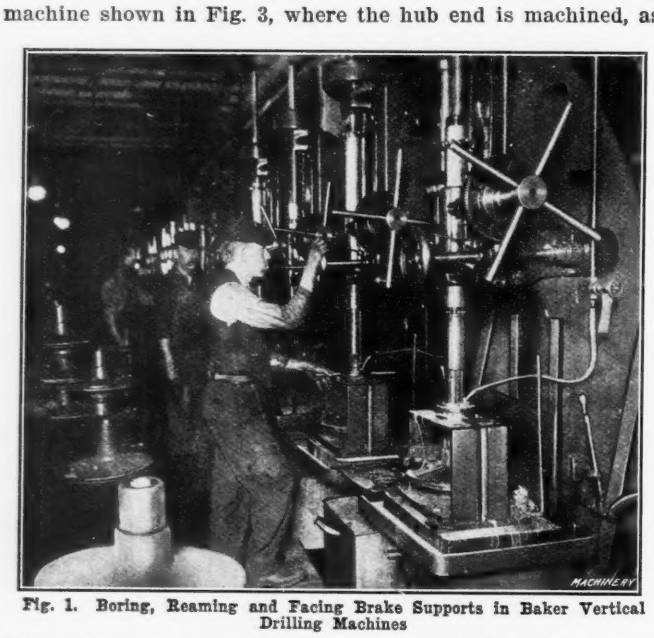


Fig. 1. Boring, Reaming and Facing Brake Supports in Baker Vertical Drilling Machines

indicated on the casting shown at *A*. The brake hub is located from the previously reamed hole on a fixture fastened to the table of the machine, and is prevented from rotating by a stop which comes in contact with the arm. The large hollow mill used for performing this operation is of the inserted blade type, the blades being held in place by two adjusting ring nuts which clamp them in grooves provided in the body of the mill. It is also provided with a hardened and ground leader which fits in the previously reamed hole in the hub end, thus making the external diameter concentric with the bore. The total depth turned is 3.03 inches, and ⅜ inch of material is removed from the diameter, bringing the hub end of the brake support to 2.9350 inches. This operation is handled at such a rapid rate that a product of 200 finished castings in nine hours is obtained.

Boring and Tapping Transmission Cases

An operation which is seldom accomplished on a drilling machine of the vertical type is the boring and tapping of transmission cases. The Reo Motor Car Co., however, performs

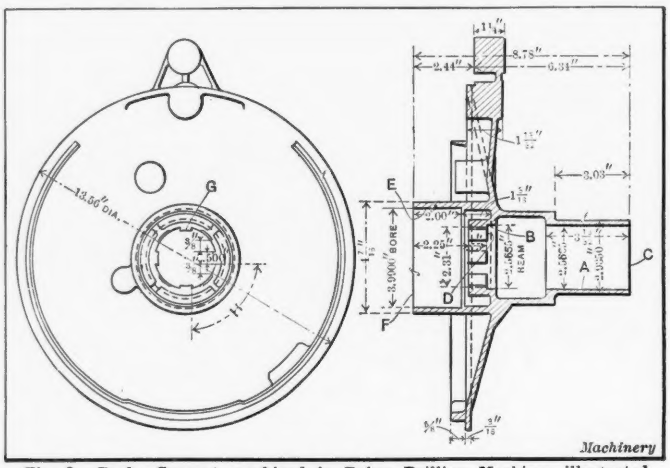


Fig. 2. Brake Support machined in Baker Drilling Machines illustrated in Figs. 1 and 3

this operation on a Baker vertical drilling machine, illustrated in Fig. 4, with satisfactory results. A special jig, a view of which is shown in Fig. 5, and in detail in Fig. 6, is used for this purpose. Referring to Fig. 6 it will be seen that the jig consists of a base *A* provided with lugs which are used in clamping the jig to the column of the vertical drilling machine —this having been provided with T-slots for the purpose. The bracket *B* carrying the jig proper which holds the work, is free to rotate in the base *A* when the handle *C* is operated, withdrawing the locking plunger. This locking plunger fits in bushed holes in the bracket, and thus provides for indexing the jig and enabling the holes in each end of the transmission case *A* to be machined.

It will be noticed in Fig. 4 that the transmission case *A* has two holes in each end, so that to machine both holes in this jig it is necessary that means be provided for rotating the jig *D* around its vertical axis. This is accomplished by having the axis of the trunnions on jig *D* out of line with the axis of the spindle an amount equal to half the distance between the two holes in the end of the work. The arms of bracket *B* carrying the trunnion are split as shown, and provided with a clamping bolt for giving the proper tension on the rotating member of the jig. To rotate the jig around its vertical axis, the handle *E* is operated, withdrawing the locking plunger (see Fig. 6) and thus permitting the jig to be rotated to bring the two holes alternately in line with the spindle of the machine. The transmission case is located in the jig by the machined arms and is held up against the finished surface on the jig by two swinging clamps *G*. The operations performed consist in rough-reaming the first hole with a stepped reamer to 3.490 and 3.3917 inches. The jig is then indexed on its vertical axis and the operations repeated on the other hole. This hole is then tapped 0.010 inch under size (3½ by 12 pitch). The jig is then indexed back and the other hole tapped. After this, it is indexed on its horizontal axis and the operations repeated. The 0.010 inch finish is removed by hand after the cases have seasoned. By the use of this jig thirty-three finished transmission cases can be turned out in nine hours.

Jig for Drilling and Reaming Automobile Drive Shafts

The type of jig used in drilling and reaming the holes in the bosses of automobile drive shafts is shown in Fig. 7. This consists of a cast-iron body *A* which is fastened by bolts and dowels to one end of the base *B*, the other end of the base

* For information previously published in MACHINERY on automobile manufacture, see "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and other articles there referred to.

†Associate Editor of MACHINERY.

carrying the support *C* for holding the shaft parallel while the hole in the opposite end of the shaft is being drilled and reamed. The work is prevented from swinging around in the jig by a stop *D*.

The clamping mechanism is interesting and works on the cam principle. It consists of a sleeve *E* having a tapered hole in it that fits over the boss on the end of the drive shaft, which is operated by a two-handle clamping nut *F*. The flange of the clamping nut is cut away to clear the locking straps *G*, so that the sleeve *E* can be withdrawn in order to remove the work. As soon as the pressure is relieved from the sleeve *E*, it is raised automatically by two open-wound coil springs *H*. The sleeve is prevented from coming entirely out and rotating by the headless screw *I*, which works in a groove in the sleeve.

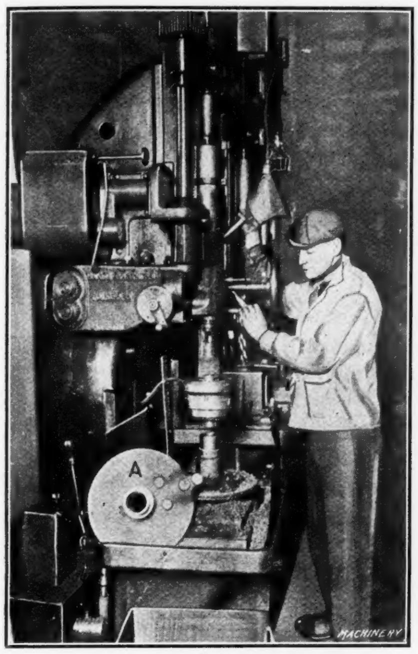


Fig. 3. Hollow-milling Hub End of Brake Support in Baker Drilling Machine

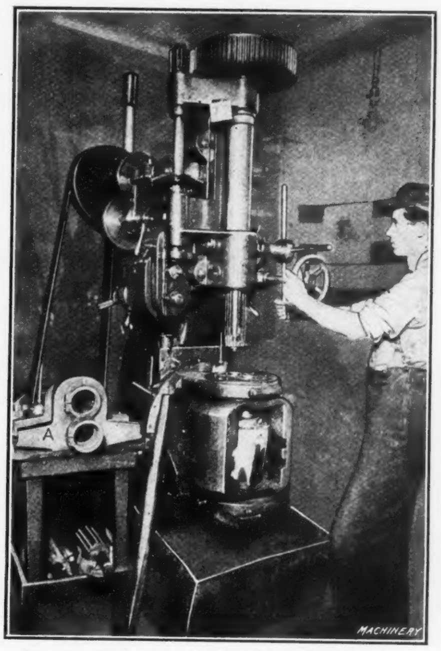


Fig. 4. Boring and Tapping Transmission Cases in Baker Drilling Machine

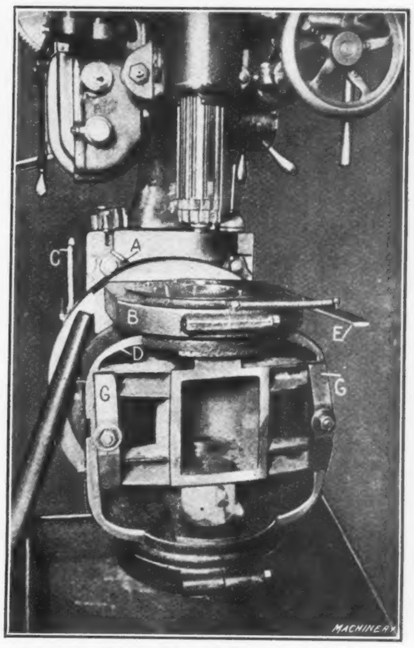


Fig. 5. Close View of Jigs and Work illustrated in Fig. 4

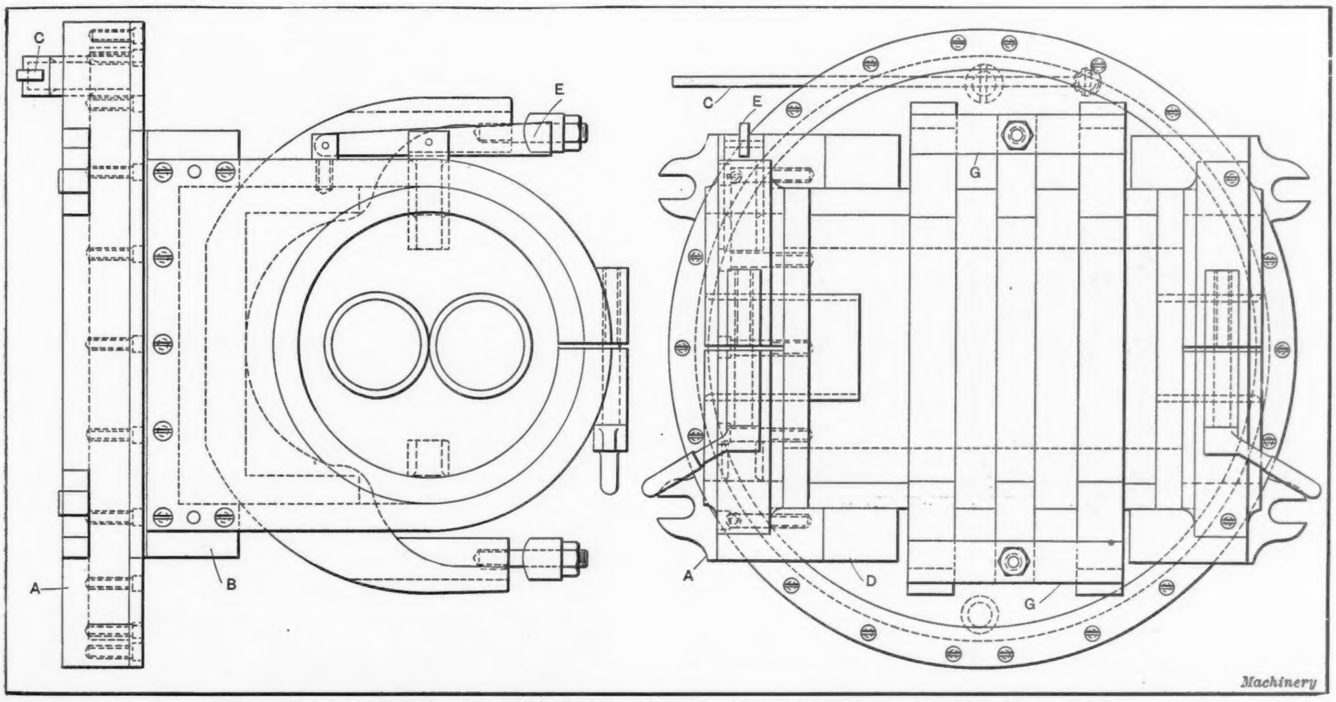


Fig. 6. Details of Rotating Jig used in boring and tapping Transmission Cases shown in Figs. 4 and 5

The bushing used for guiding the drill and reamer is carried in this sleeve, which is tightened on the work by giving the handle a quarter turn, bringing the cam portions under the two blocks *G* fastened by screws and dowels to the main casting. The clamping nut *F* is held down on a seat on the sleeve by the nut *J*. A pipe *K* for supplying lubricant to the drill or reamer is inserted completely through the sleeve, an elongated slot being cut in the latter for this purpose. Through this pipe, oil or any cutting lubricant can be supplied directly to the cutting tool when it is at work in the hole. This type of jig can be operated very quickly and forms an efficient device for machining work of this kind.

Drilling Crank-cases in Multiple Spindle Drilling Machines

The drilling of holes in the crank-case is an operation which the majority of automobile manufacturers accomplish in a multiple spindle drilling machine, but there are a diversity of methods employed in this work. An interesting and efficient type of drilling jig which is applied to a National multiple spindle drilling machine is shown in Fig. 8. This jig is so arranged that it is possible for the operator to keep the machine in practically continuous operation. To the left of the machine table is a track arrangement *A*, similar in construction to that shown at *B* at the right of the machine. These two stands, in conjunction with the "track" jig *C* on the table, enable the work to be handled in a rapid manner.

The method is as follows: A casting is placed on the jig *C*, the machined arms of the crank-case resting on the four hardened locating plates *D*, but before placing the casting in this position the bushing plate *E* is put in place. Now while the machine is in operation (using the automatic feed) on the

casting on the table, the operator places another casting on the stand to the left and puts the extra bushing plate *F* in place. Then when the casting on the table of the machine has been drilled, the operator drops the table down quickly and slides the casting over into position on the track to the right at *B*. Then he removes the casting from the stand to the left placing it in a position under the drills and starts the machine in operation again. It will be noticed that the tracks at both sides of the table of the machine are lower than the drill jig;

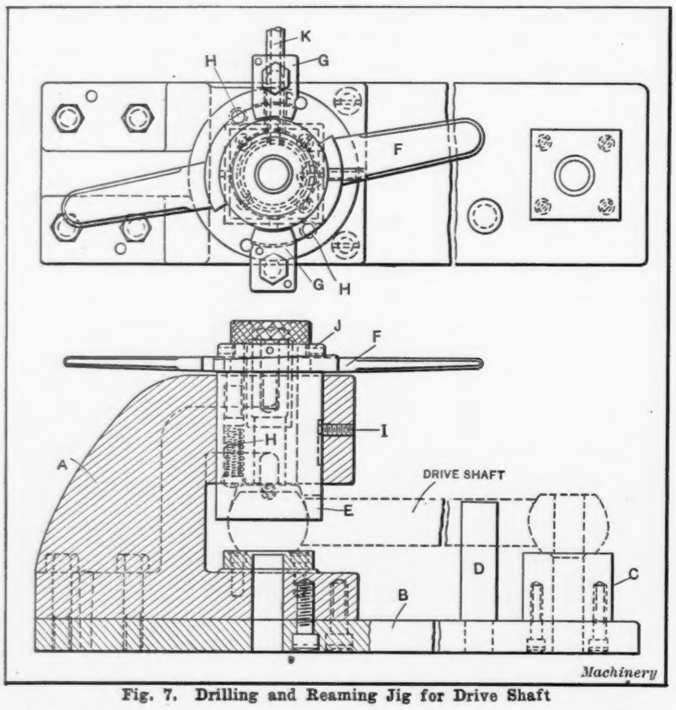


Fig. 7. Drilling and Reaming Jig for Drive Shaft

this is due to the fact that the drills are in operation and the table is raised. When the table is down all the tracks are in line.

It is astonishing how quickly these cast-iron crank-cases can be drilled when handled in the manner illustrated in Fig. 8. There are twenty-five holes in the crank-case varying in diameter from 13/64 to 27/64 inch, and the greatest depth is ¾ inch. With the arrangement illustrated it is possible for one operator to turn out an average of 210 completed crank-cases

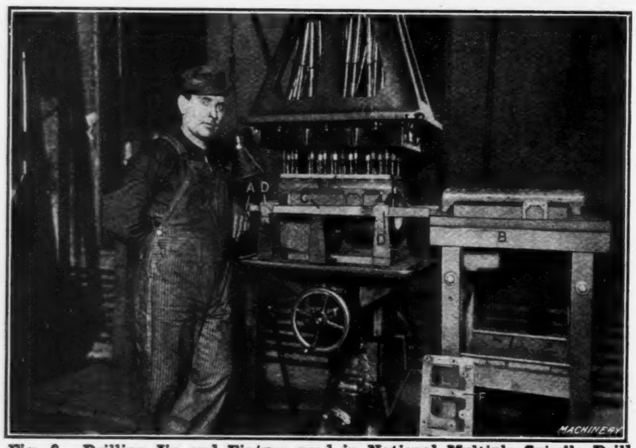


Fig. 8. Drilling Jig and Fixture used in National Multiple Spindle Drill for drilling Twenty-five Holes in the Top Faces of Crank-cases

in nine hours, which means a total of 5250 holes to his credit. It is easily seen that such a remarkable production would be utterly impossible were this means of arranging the work not employed.

Tapping and Studding Crank-cases

The studs which are used in conjunction with nuts for holding the engine cylinders on the crank-case are made in screw machines and are inserted with an Errington stud setter. The fixture and method employed in tapping and studding the crank-case is worthy of special mention. Referring to Fig. 9, it will be seen that the fixture consists of a casting *A* having four arms to which two rails or tracks *B* are fastened. These are machined on their top faces and guide the crank-case by the machined face of the arms on the latter. The machine used is a W. E. Gang high-speed radial drilling machine supplied with a tapping attachment. The operator first taps all the holes, which are twenty-six in number and are of the following sizes: Five ⅜ by 16, eight ¼ by 20, twelve ½ by 13 and one ½ inch pipe tap. The actual time for tapping the twenty-six holes in this crank-case is four minutes and the twenty-five studs are inserted in approximately three minutes.

The stud setter is a small tool somewhat similar to a threading tool and carrying a two-piece jaw shaped like a split die. This is brought in contact with the work, the stud hitting a shoulder on the tool, whereupon the jaws close tightly on the work and screw the stud into the crank-case. As soon as the proper depth is reached, it releases from the stud automatically and is drawn up by the handle as shown in the illustration. The crank-case is slid back and forth on the track and the arm of the radial drilling machine is swung around so that it is a simple matter to line up the stud setter or tap with the holes. Some idea of the rapidity with which these operations are accomplished is obtained from the production—the tapping and studding of sixty-four of these crank-cases in nine hours.

Keyseating Live Shafts for Rear Axles

The keyseats in the propeller shafts which form a means for connecting the universal joint on each end are produced in Kempsmith-Lincoln type milling machines as shown in Fig. 10. These propeller shafts, which are made from Carpenter Sampson steel, are held four at a time in special fixtures. A detail of the fixture used in holding the four live shafts while cutting the keyway in the tapered end is shown in Fig. 11. Referring to this illustration, it will be seen that the clamping mechanism used for gripping the shafts is unique and very effective. Fastened to the top part of the fixture are five strips *A* which are machined out, as indicated, to fit the tapered ends of the four live shafts. The main body of the fixture is also machined to a similar shape and is provided with a slot in which four clamping blocks *B* work. These are fastened by screws to two rocker blocks *C*, the latter being pinned to a cross-bar *D*. Cross-bar *D* is operated by a cam *E* which forms

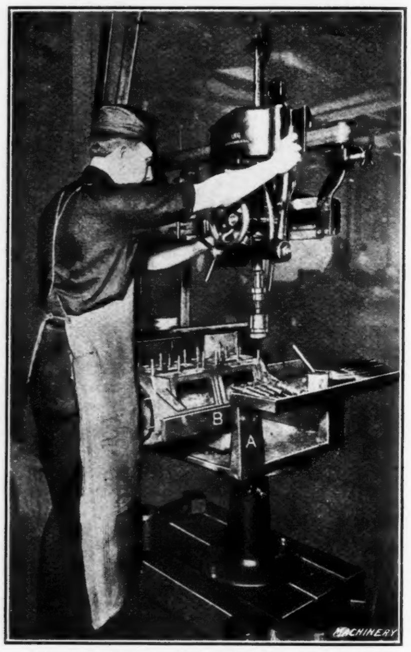


Fig. 9. Tapping and Studding Crank-cases in a W. E. Gang Radial Drill

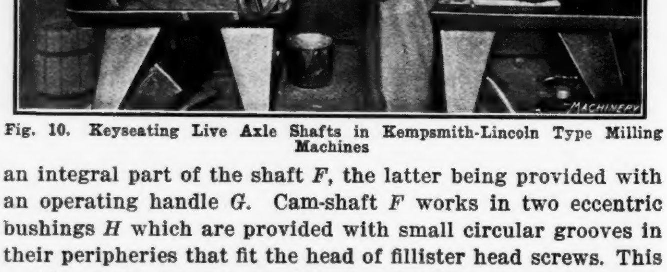


Fig. 10. Keyseating Live Axle Shafts in Kempsmith-Lincoln Type Milling Machines

an integral part of the shaft *F*, the latter being provided with an operating handle *G*. Cam-shaft *F* works in two eccentric bushings *H* which are provided with small circular grooves in their peripheries that fit the head of fillister head screws. This enables the bushings to be rotated and held in the desired posi-

tion, in order that the handle will clear the cutters of the milling machine and also be in the most convenient position for the operator.

In operation, the shafts mentioned are placed in the grooves of the fixture and rest on a bar *I* in which a groove is cut forming a guiding means for the endwise position of these live shafts. Pins, as shown in Fig. 10, are driven into the cross strip *I* so that the proper location of the shaft on this strip can be quickly obtained. When the shafts are placed in position, the operator grips handle *G* and turns it around until the work is clamped. The action, it will be seen, is as follows: As handle *G* is rotated, the cam on shaft *F* raises the cross-bar *D* and through the swinging members *C* forces up the four blocks *B* holding the work rigidly against the strips *A*. Having the members *C* pinned in this manner makes it possible to distribute the pressure equally on all four shafts and thus hold them rigidly in position. The fixture used for holding the propeller shafts when cutting the keyway in the straight end is

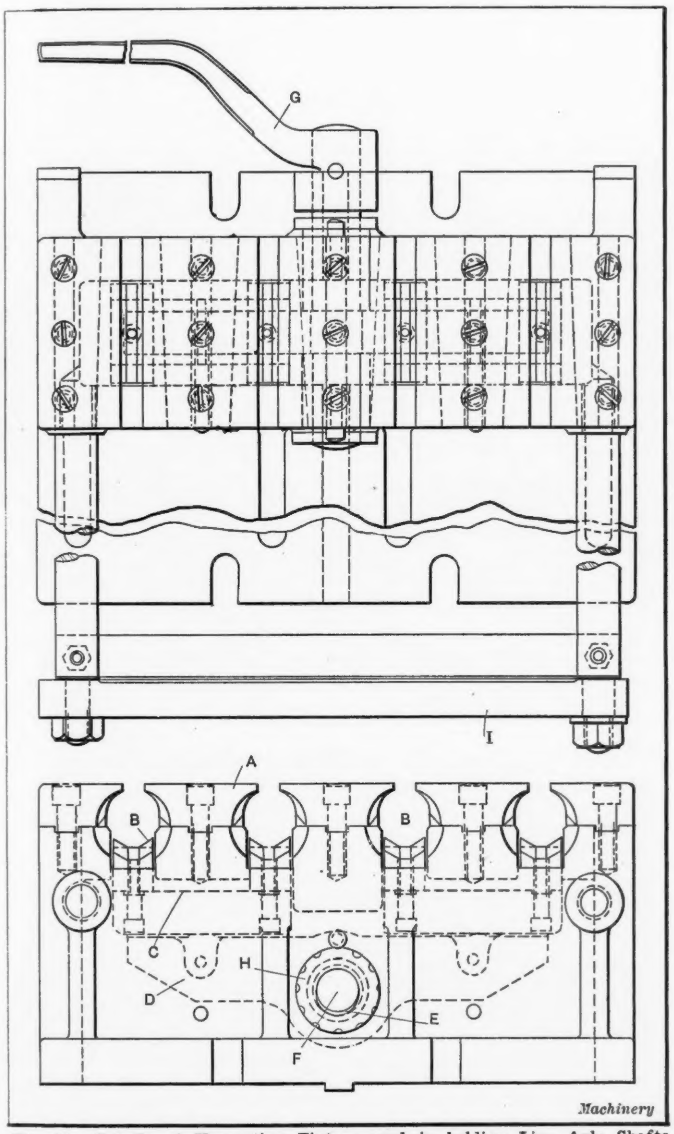


Fig. 11. Details of Keyseating Fixture used in holding Live Axle Shafts for cutting the Keyway in the Tapered End

shown to the right in Fig. 10, and is similar to that just described, except that it holds the shafts in a parallel position.

Milling Fixture for Inlet Valve Levers

Another interesting type of milling fixture which is used for cutting the slot *A* in inlet valves is shown in Fig. 12. This fixture consists of a cast-iron base *B* held to the table of the milling machine and provided with two projecting bosses on each end. These are machined to fit jaws *C* that are operated by a shaft *D* provided with right- and left-hand threads, respectively. The work is held in the manner indicated, being gripped by the jaws over the part of the valve lever in which the slot is to be cut. To prevent springing the work, a stud *E*, which also serves the additional purpose of guiding the work from the hole, comes against one of the jaws—being held in the other. This acts as a stop and prevents the jaws from squeezing the work too tightly and thus springing the lugs formed by the slot. The fixture is operated quickly and forms a very effective means of holding work of irregular contour.

Machining Transmission Ends for Drive Shaft Universals

A good example of the important function filled by engine lathes in the automobile factories is shown in the manufacture of transmission ends for universal drive shafts, Fig. 15. This

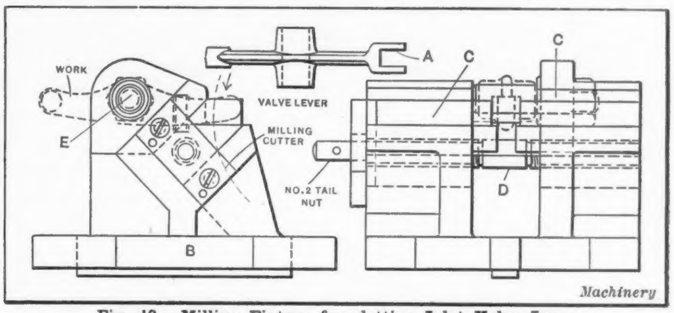


Fig. 12. Milling Fixture for slotting Inlet Valve Lever

part is made from 15 point carbon open-hearth steel and is drilled and reamed before being brought to the engine lathe shown in Fig. 13. It is held on an expanding air chuck, being gripped from the hole, and the small end is reduced to approximately the correct diameter in one cut. This means a reduction of 1½ inch in diameter—a depth of cut of ¾ inch on a side—the actual time to complete this roughing operation being

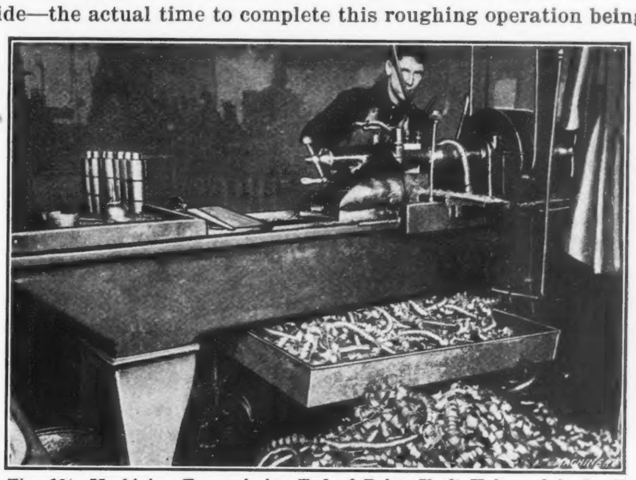


Fig. 13. Machining Transmission End of Drive Shaft Universal in R. K. LeBlond Engine Lathe

31 seconds. This first cut is made on all the pieces and they are afterwards finished to the sizes given in the illustration Fig. 15, which, of course, are the rough dimensions, sufficient material being left for grinding all over.

Fig. 14 gives a better idea of the depth of cut taken on this machine and also gives a better view of the method of holding the work. The expanding air chuck *A* is provided with a

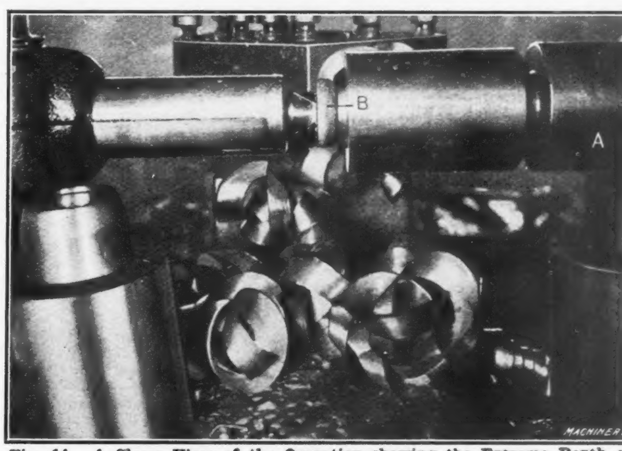


Fig. 14. A Closer View of the Operation showing the Extreme Depth of Cut taken

shank fitting the largest diameter of the piece and is reduced slightly more than the smaller diameter; it is also threaded on the end for the reception of the hardened nut *B*. This is provided with a center, and is guided by the tailstock center in order to prevent the thrust of the tool from springing the arbor of the air chuck, which would certainly occur in taking such a tremendous cut.

Machining Valve Plunger Guides

The valve plunger guide shown in Fig. 17 is a good example of the work which can be handled in the automatic chucking machines of the type shown in Fig. 16. The work is held in specially formed chuck jaws fastened to the head which is provided with one more position than the number of spindles on the machine. The manner of holding the work and applying the tools to it differs from the usual method of handling work on automatic screw machines. In this case, the work is held stationary (except for being traversed longitudinally and indexed) and the cutting tools are rotated. This machine is provided with four spindles which are rotated at a speed most suitable for the proper working of the tools that they carry.

The order of operations on this piece is as follows: first, drill a 63/64-inch hole half way through, and rough-turn outside diameter with a hollow mill; second, drill hole completely through and take finishing cut from outside diameter with hollow mill; third, counterbore; fourth, ream completely through. It is evident, of course, that the reamer has to travel twice as far as the other tools in the work, so that the reamer head is operated by a separate cam to provide for

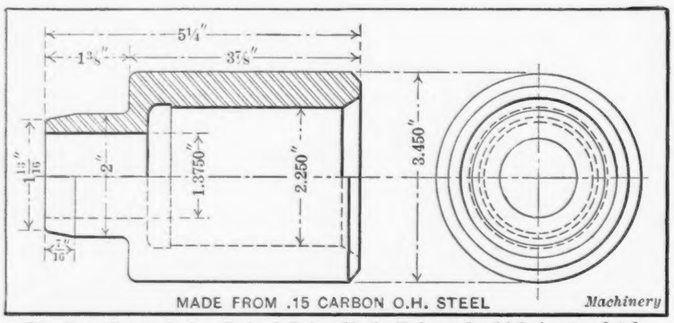


Fig. 15. Transmission End of Drive Shaft Universal which is completely turned in R. K. LeBlond Engine Lathe

this additional amount of travel. The machine works practically automatically but, of course, requires the attention of the operator to insert and remove the finished work. The machine is provided with one more chuck than spindles; hence there is always one vacant position from which the operator can remove a finished casting and insert a rough one. It is evident from this that the production from a machine of this type must be great, and this example is a case in point—130 of these finished castings being turned out every hour.

Broaching Brake Supports

The brake support shown in Fig. 2 which is attached to the housing enclosing the rear axle is subjected to considerable torsional strain, and hence it is necessary that a suitable means be supplied for holding it rigidly in place. This is

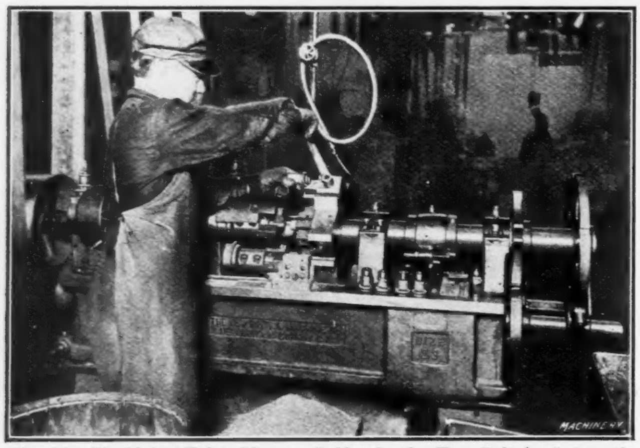


Fig. 16. Machining Valve Plunger Guides in the New Britain Automatic

accomplished by broaching a series of grooves, four in number, in the brake support, thus forming tongues *G* and by cutting corresponding slots in the housing enclosing the rear axle. The operation of broaching is handled as shown in Fig. 18 in a La Pointe broaching machine which is provided with an arm on the faceplate carrying a stud for locating the brake support in the proper position, and also preventing it from turning. The broach, as shown, is provided with teeth equal in circumference to the space indicated by the distance *H* in Fig. 2, as it is from this point of the brake support that the metal is to be removed to form the tongues. This hole is completed in one pass of the broach and at the rate of 200 per day of nine hours.

Riveting Main Drive Gears to Differential Case

In the automobiles built by the Reo Motor Car Co., the main drive gear instead of being bolted is riveted to the differential case, and this operation is handled very quickly by the Chicago pneumatic riveter, illustrated in Fig. 19. This riveter is provided with a lower "anvil" having a lug that fits around the

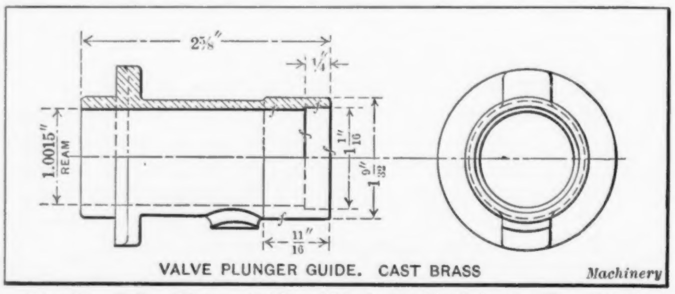


Fig. 17. Valve Plunger Guide which is machined in the New Britain Automatic shown in Fig. 16

stem of the differential case and a riveting punch of the proper size and shape held in the ram. The main drive gear is first assembled on the differential case and held in position by three bolts, which are removed as the riveting progresses. The operator then brings the assembled members to the machine shown in Fig. 19, and the 3/8-inch cold-rolled steel rivets are placed in the holes. As the rivet heads are not exactly square, a hardened collar is placed over them in order to enable the upsetting of the lower end of the rivet to be accomplished without distorting the projecting part. As soon as the lower end of the rivets have been upset all around, the operator removes these hardened nuts and then by one operation of the arm for each rivet, completes the formation of the

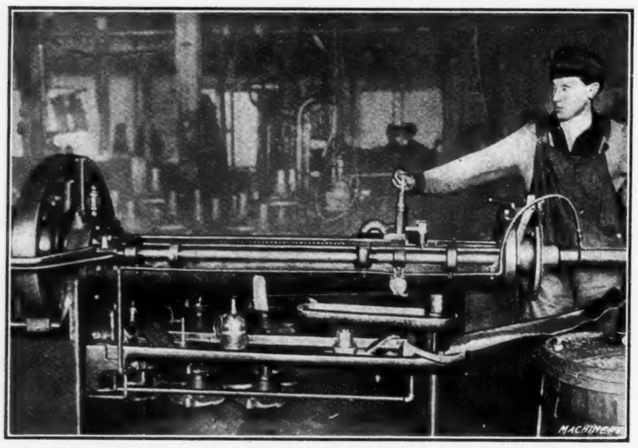


Fig. 18. Broaching Brake Supports in Lapointe Machine Tool Co.'s Broaching Machine

rivet heads—thus binding the differential case and main drive gear solidly together. This operation is handled much more quickly than is possible by tapping, inserting bolts and screwing nuts onto them, as is the usual practice.

Testing Motors and Completed Cars

The practice followed in testing motors and completed cars differs to a considerable extent in the various automobile factories. The motors, as a rule, are all tested on a stand by belt power and then run on their own power for three or four hours to see that everything is working properly. The practice followed by the Reo Motor Car Co. is as follows: The motors are run on a stand by belt for from four to six hours and are then taken apart and the bearings readjusted. After this they go to the inspection department where the cylinders are removed and the pistons, rings and bearings, examined. When everything has been examined, the motors are installed in the complete chassis. After the motor has been fastened to its proper place in the chassis, it is run on its own power on special "Sirocco" blowers. Pulleys *A* (see Fig. 20) are put on the rear axles instead of wheels, and these are belted to the blower, which is to be rotated at a rate of 35 miles per hour, requiring 30 horsepower to drive—this tests the engine at its

rated capacity. The air from the blower is used to cool the motor, being brought down through the pipe *B*. After the motors have been subjected to the test outlined, the chassis with motor in place is taken to what is known as the load test. Here the pulleys on the axles are set up and belted as before, but in this case to a rotary pump. Then by means of a heavy spring valve, a full load at any speed can be imposed on the motor so that its efficiency is tested in a more accurate manner than if the car were taken out for the regular road test.

The road test which is still employed by some manufacturers has several disadvantages. In the first place, the wear and

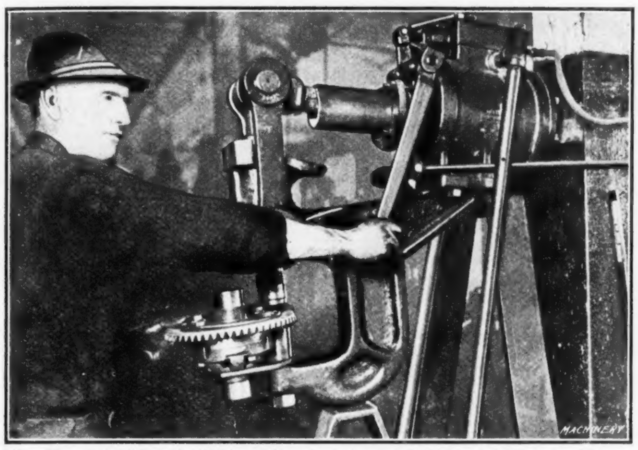


Fig. 19. Attaching the Main Drive Gear to the Differential Case by Means of a Pneumatic Riveter

expense of tires is enormous, and in the second place, unless the automobile company has especially prepared tracks of their own, it is difficult to obtain permission from the community to allow them to drive their automobiles at a high rate of speed up and down the public streets. There is also the additional trouble of bringing the car in, washing and cleaning it, and the still further objection that if many cars are produced in a day, it is practically impossible to find a place to test them out. The means of testing employed by the Reo Motor Car Co. subjects the motor to just as rigid a test

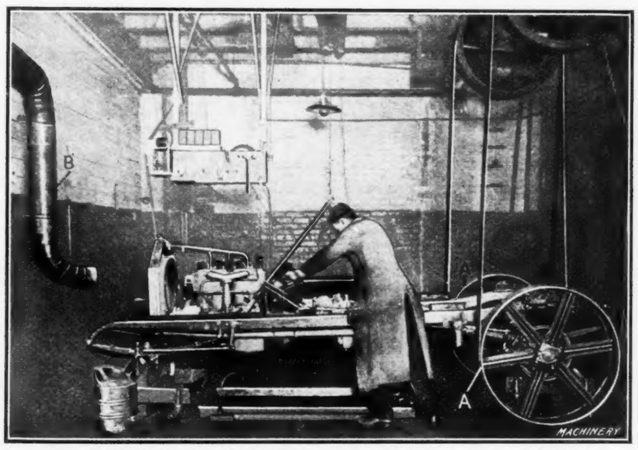


Fig. 20. Subjecting Completed Motors to what is used as a Substitute for the Road Test

as it receives on the road, and even more so, and has the advantage of being accomplished in a more scientific and much more rapid manner. Of course before the car is sold, it is taken out and run around for a short time; this is not done to test the engine or any of the working parts, but just to see that the other mechanical movements of the car are perfect in every respect.

* * *

An English automobile manufacturer has brought out a motor car to meet the peculiar requirements of some of the British colonies. This car can be driven for miles through water four or five feet deep without difficulty. All electric conduits, magneto and batteries are protected by special insulations, and extra lengths of pipe are attached to the exhaust pipe and to the intake manifold. When a car of this type is driven through five feet of water, only the top of the radiator and the seats are located above the water surface.

DONT'S FOR DRILL GRINDERS*

BY JAMES B. COOLEY†

Don't fail to tighten the back-stop screw.

Don't run the lip rest against the wheel.

Don't put your oily hands on the wheel.

Don't forget to grind both the drill lips alike.

Don't let the drill extend too far over the lip rest.

Don't place the fingers on the drill too near the wheel.

Don't have your face directly over the wheel when grinding.

Don't shut the grinder off and continue grinding on the wheel.

Don't start to grind the drill until the wheel has fully started.

Don't grind a drill by hand when there is a drill grinder in the shop.

Don't use the grinder wheel for any other purpose but grinding drills.

Don't swing the drill over the wheel too quickly; give it a chance to grind.

Don't remove the drill from the holder until the wheel has stopped running.

Don't lean on a drill when grinding; it is likely to tip up and gouge into the wheel.

Don't make several trips to the grinder; do all the grinding you can in one trip.

Don't fail to try all the screws to see if they are tight before you attempt to grind.

Don't try to grind off too much at one time or you will take the temper out of the drill.

Don't turn the feed-screw around too far after each cut or you will burn the drill.

Don't kick the shipper treadle over as if it were a foot-ball; push it over carefully.

Don't attempt to turn the drill over in the holder unless you are sure the arm is clear back.

Don't let the point of the drill become too thick; narrow it down on a small emery wheel.

Don't attempt to grind a drill in a drill grinder, unless you have first been shown how.

Don't forget to set the drill for the correct angle before placing it in the drill holder.

Don't grind a drill half way up the lip but grind over the entire length of the cutting edge.

Don't get nervous the first time you use a drill grinder; keep a cool head and grind slowly.

Don't swing the arm forward by pushing it with the fingers, but grasp it with the whole hand.

Don't forget that when you burn the end of the drill it must be ground further back or it will not cut well.

Don't fail to clean out the emery dust from the drill holder before putting in a drill—but don't do it while the machine is running.

* * *

According to the *Brass World*, the source of metallic iridium is the powder left after the platinum has been extracted from the ore by the wet method. Iridium powder cannot be smelted alone but must be converted into a phosphide in order to melt it and obtain it in a reguline mass. The iridium powder is heated in a silica crucible and pieces of phosphorus added to it until enough has been absorbed to convert it into the phosphide and render the mass liquid. The phosphorus must then be removed, and this is accomplished by heating the iridium phosphide with lime. When the phosphorus is extracted a white, brittle and very hard mass of metallic iridium is left, which cannot be filed or cut, but in order to obtain it in small pieces it is broken by hammering. The small pieces are used for the points of gold pens and are fused by means of gold solder to the points of the pens, after which they are ground with carborundum to shape and polished. It is said that the iridium thus produced is about as hard as the ruby. The use for the points of gold pens is the chief one. The manner of applying this metal to pen points was described in the article: "Fountain Pen Manufacture," in the January, 1912, number of MACHINERY.

* For "Don'ts" previously published in MACHINERY, see "Don'ts for the Manager," November, 1912, and the "Don'ts" there referred to.
† Address: 46 Wyllys St., Hartford, Conn.

MAKING A SMALL TURNBUCKLE

BY A. M. ROCHESTER

On adding machines, typewriters, and other small machines, a number of small turnbuckles are used. They are screwed on threaded wires to adjust the tension of coiled springs attached to them. Nearly one hundred of these turnbuckles are used on one of the well-known makes of typewriters. One of these turnbuckles is illustrated in Fig. 1.

The turnbuckles are made of a special grade of annealed wire, 0.103 inch in diameter, and some interesting tools are used in manufacturing them. Blanks of the proper length are cut from the wire and the order of operation is then as follows: First, bending; second, swaging; third, trimming; fourth, drilling; and fifth, tapping.

The Bending Operation

The punch and die used for bending over the end *A* of the turnbuckle are shown in Fig. 3. The wire is laid in the groove *B* and pushed along until one end reaches the edge of the stripper-plate *C* and the other end projects from the die. The work is stopped at the right place by the tool which is used to push it along striking against the edge of the stripper. To prevent the work from being drawn out of the die in bending, the spring plunger *D* is provided.

The edge of the die has a semicircular groove cut in it and so has one side of the square punch *E*. When this punch descends, it bends the wire at right angles, and when the bending is completed the finished part is pushed out of the die by the next one that is pushed into place. The finished

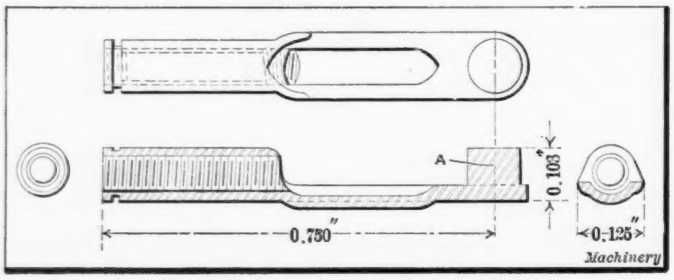


Fig. 1. Turnbuckle used to adjust Spring Tension

parts fall through a hole in the base and are caught in a pan placed to receive them. Bending dies of this type are largely used in the factory referred to for producing a number of different parts made from wire and have proved to be very satisfactory.

The Swaging Operation

The punch and die shown in Fig. 2 are employed for the next operation which consists of swaging the work to the shape shown in Fig. 1. It will be seen that this punch and die are designed to handle four pieces at a time. The bent-over ends are inserted in the holes *F* and the work is held in place between the pins as shown. Pieces of hardened drill rod *G*, which form the shape to which the work is swaged, are soldered to the face of the die in the position shown. This construction makes it an easy matter to renew these parts as they become worn. The punch is a square block of hardened tool steel, having the proper shape for producing the opposite sides of the work. When the swaging is completed, the parts are ejected by pins that are raised in the holes *F* by the action of an eccentric roll operated by the lever at the right of the die.

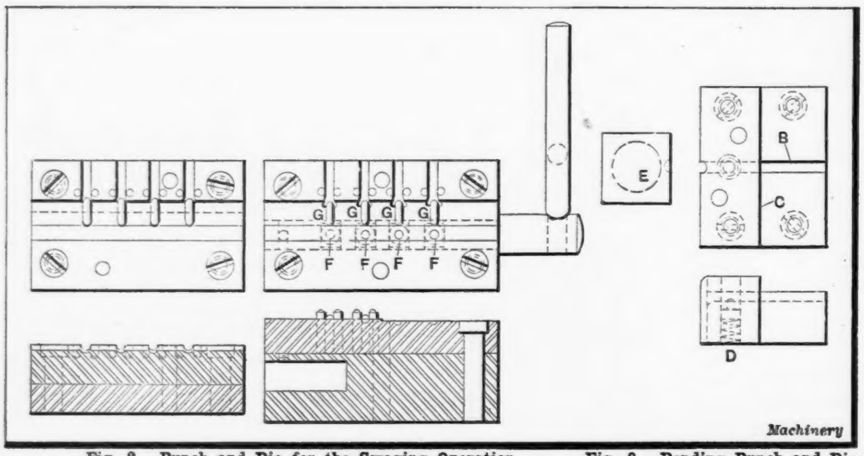


Fig. 2. Punch and Die for the Swaging Operation Fig. 3. Bending Punch and Die

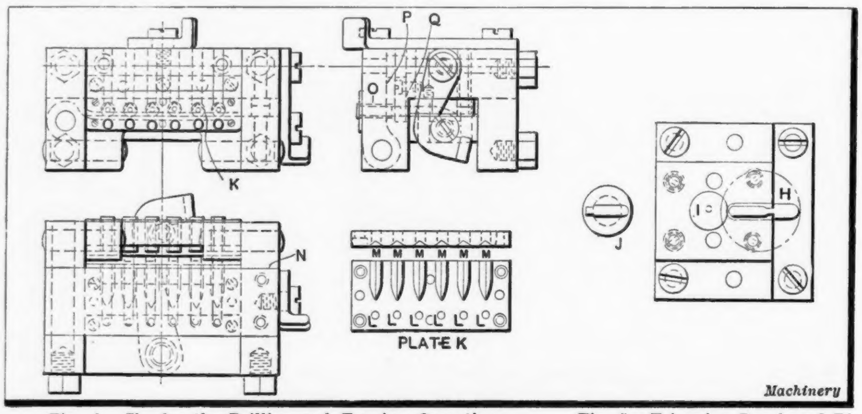


Fig. 4. Jig for the Drilling and Tapping Operations Fig. 5. Trimming Punch and Die

Trimming the Work

Trimming away the surplus stock or "flash" from the swaged portion is the next operation. The punch and die shown in Fig. 5 are used for this purpose. The work is located by inserting the bent-up end in the hole *H* and pushing it along into contact with the locating pin *I*. When the punch *J* descends, it trims off the "flash" and forces the work down through the die.

Drilling and Tapping

The jig shown in Fig. 4 is used for drilling the hole in the end of each piece. This jig takes six pieces of work at a time. Reference to the detail view of the plate *K* will show the design. The bent-up ends are inserted in the holes *L* while the body of each piece lies in one of the grooves *M*. The parts are held in the jig by the leaf *N*, which is clamped in position by a suitable latch as shown. The drilling operation is done through the bushings *O* that are carried by a leaf *P*. This leaf has a hardened protection plate to prevent it from being damaged by the drill. After the drilling operation is completed the leaf *P* is raised ready for the tapping operation. The tap is now guided by holes in the plate *Q*, which is fastened to the body of the jig just beneath the leaf.

* * *

DECISION ON FIXING RESALE PRICES

The U. S. Supreme Court handed down a decision May 27 of great importance to manufacturers who establish and maintain resale prices of their products. The practice of fixing resale prices of patented articles by making a violation of the contract between the manufacturer and the dealer an infringement, has become common during recent years. The Supreme Court has decided in the case of Bauer Chemical Co. vs. James O'Donnell, a druggist in Washington, D. C., that while the patent law gives the owner exclusive right to make and sell patented articles, it does not give the right to fix the price at which they shall be sold. The decision apparently upsets the Dick mimeograph case, which virtually gave a patentee absolute control of his inventions after they had been sold and paid for. The decision apparently removes all legal control of resale prices of patented manufactured goods. The fixing of resale prices by agreement is in violation of the Sherman law which states that there shall be no restraint of trade.

* * *

One of the troubles with some cost-keeping systems, says one of our contemporaries, is that they cost too much to keep up.

SYSTEM FOR THE DRAFTING OFFICE, PATTERN SHOP AND FOUNDRY

OUTLINE OF METHODS OF MANAGEMENT THAT SAVE TIME AND ELIMINATE MISTAKES

BY F. TISSINGTON*

One of the most frequent causes of trouble in a foundry making a miscellaneous assortment of castings is due to the necessity of hunting up an old pattern for a repeat order some time after the original castings were made. It seems to be the practice of many shops to put these patterns away in any convenient place in the store rooms, and this usually entails a general search before the required pattern is found. Moreover, some of the patterns are likely to be similar in shape and general dimensions, only varying in minor details which are apt to be overlooked by anyone not entirely familiar with the particular reasons for such variations. Then again, if the foreman of the pattern shop has a rush job on hand and cannot find the pattern that is required, he is likely to look up an existing pattern and remodel it to suit the work in hand without making any record of what he has done. A repeat order for the original casting will then be executed from the altered pattern, without anybody being the wiser until the customer starts to "kick." Mistakes of this kind are always likely to happen in a shop where too much is left to the memory of a few men who may leave the establishment at any time, and it is at these periods that the necessity for a reliable and permanent system is most keenly felt. Too much system is, of course, as bad as not enough, but the following scheme has been tried out and found to work well with patterns of a miscellaneous character and, therefore, it should be easier to apply it to specialized work. The writer wishes to say that he believes those people are wrong who think anything in the shape of system will increase the working costs, for his own experience has shown that a system that is carefully thought out and properly operated will materially reduce the working costs and also get more intelligent and efficient work from the men.

One system, however, will not suit every factory, and it is probably owing to lack of careful thought and preparation that so many schemes fail. This article is simply intended to give the general outline of a system, and modifications should be made to suit the particular circumstance. First of all, the writer will ask a few pertinent questions which will indicate the usual weak places in an organization.

The Drawing Office

(1) If there is no easy and sure method of locating any pattern that may be required, what are the chances that the designing staff will be in a position to use it again instead of making a new pattern?

(2) If no systematic record is kept of alterations to patterns, how are repeat orders carried out and is it possible to tell the foreman how to do the job in the most economical way?

(3) How many times a week or month does a member of the designing staff hunt around the store looking for a pattern that he has an idea should be there?

(4) Are records kept of what each casting weighs for use in making future estimates?

The Factory

(1) Can the foreman turn up a particular pattern at a moment's notice?

(2) Is a drawing required every time to locate the pattern for a repeat order or is the reference number enough?

(3) How many times does the foundry supply too many castings or not enough to complete the order?

(4) How many patterns are made in the course of a year that would be unnecessary if accurate records were kept?

These are a few instances when working costs may be considerably higher than is strictly necessary, because it will not cost as much to do the thing right as it will to make a mistake, do unnecessary work, and run the risk of offending customers.

The System

Starting in the drawing office, the first step is to standardize drawing sizes. A very good combination is 12 by 18 inches, 18 by 24 inches and 24 by 36 inches. The first is one fourth and the second one half of the last size given, and, therefore, a distinct economy is effected from the possibility of using 36-inch drawing, tracing and blueprint paper which will cut up without waste. If anything else is made besides castings, the better course to adopt is to provide a separate filing cabinet and register for the castings. The system should be laid out on the following plan. Number all the drawings in the sequence in which they are made, irrespective of the size of the drawing or class of the casting; and file the drawings away in drawers in numerical order. The three sizes should be kept separately, otherwise the smaller ones are liable to get lost among the largest sizes. It will be easy to find where the drawing may be from its number and size, as the latter information should be entered in the register.

DRAWING REGISTER.

Drawing Number	Name of Article	Made For	Date	Pattern Number	Weight Each					Size of Drawing	Remarks
101	20" Manhole Frame.	John Thompson Ltd.	12/20/12.	Mc 20			5	3	9	18"x24"	Special Pattern.
102	6" Stand Pipe	Henry Clay & Sons.	12/22/12.	Sb 16			3	7	5	12"x18"	Standard do.
103.	Bed plate for engine (9"x18")	The Rodgers Engine Co.	12/24/12.	Bf 130	1	3	2	8	9	24 x 36"	Occasional use.

Fig. 1. Sample Page from the Drawing Register

Each pattern should be the subject for a separate drawing, and the title of the drawing should state the nature of the article which is illustrated. The name of the purchaser should be filled in and also the pattern number, actual weight of one casting, and the date when the drawing was made. A card index will be found useful, if the quantity of the work warrants it, and would be used more for the sake of cross indexing than anything else. The card index can be designed to meet the needs of a particular case. The pattern number will be obtained from a second register run conjointly with the drawing register, and in making up this second register, it is absolutely necessary to name the article correctly, as the pattern mark is dependent upon its name. The different patterns may be designated by the letters of the alphabet in the following manner. Suppose, for instance, the pattern is for a column bracket. Now this should be entered under letter *B* and not *C* because it is essentially a bracket. If this idea is carried out faithfully in indexing and marking the drawings and patterns, there will be little trouble in finding them again. The important point is to decide what the article should really be called.

Fig. 1 gives a general idea of a page of the drawing register and Fig. 2 shows a typical example of a sheet from the pattern register. It will be found more convenient to arrange the pattern register on a loose leaf book so that it can be added to when necessary. The alphabetical divisions will meet the requirements of most small factories, but if desirable these

* Address: 79 Drummond Road, Sherbrooke, Quebec, Canada.

may be subdivided again. Each particular letter will indicate perhaps a number of patterns of different sizes, shape, etc., and where any great variation occurs a small letter should be added to indicate the class of pattern as in the following: *C a* 2 may designate a pattern for a grease cup; *C b* 3 a cap for a bearing; *C c* 4 a cylinder cover; and *C d* 5 a column. The second letter merely denotes the approximate size of the pattern, and is used principally for storing the patterns in groups of the same relative size. In the pattern register, an outline sketch of the pattern with overall dimensions should be drawn, as this will save turning up a lot of drawings before the correct pattern is found. Alterations should be decided upon in the office, and a new drawing filed showing the differences. These additional drawings can often be easily produced by taking a blueprint and noting alterations on it. By this means the state of the pattern at the present time is known.

PATTERN REGISTER.

B.

Pattern Number	Name of Article	Made for	Date	Drawing Number	Weight Each	Remark	Sketch
Ba1	Bearing (flange)	Jenkins Tool Co.	10/1/12	56.	2 2	Special	
Ba2.	Brass Bearing 1¼ dia	Selves.	10/9/12.	61	7	Standard	
Bc3.	Bearing Bracket.	Portland Cement Co.	11/1/12.	89	3 1 7	Special	
Bb4	Bracket (angle).	Smith & Taylor	11/21/12	95	1 5 1	"	

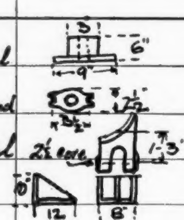


Fig. 2. Sample Page from the Pattern Register

The date when the pattern was originally made will be found useful in deciding to a large extent whether it is worth while altering it or if an entirely new pattern should be made. A further help in this direction is the insertion of a small table on each drawing, as shown in Fig. 3, as the condition of a pattern can be judged with a fair degree of accuracy from the number of castings that have been made from it, thus avoiding the necessity of looking up the pattern. This record also forms a useful reference as to the actual pattern used on a particular contract, in case the purchaser requires a repeat order and other records cannot be turned up. Another good plan to adopt is to mark each drawing plainly with the words "Standard," "Occasional use" or "Odd job," according to the requirements known at the time. This will enable the pattern shop foreman to decide what kind of pattern is the best to make and what class of wood will be most suitable. Other details will naturally develop themselves to suit particular cases.

Number	Contract	Date	Number	Contract	Date
10	763	9/12/12			
8	1018	12/21/12			

STANDARD

PATTERN No. Bb4

THE A.B FOUNDRY Co LTD.
MONTREAL
Detail of Angle Bracket for Messrs. Smith and Taylor
Made by L.R.W. Traced by H.K. Checked by J.Y.
Date 11/21/12 Scale ½ full size Revised
DRAWING No. 95.

Fig. 3. Lower Portion of Drawing showing Useful Data that is included

Pattern Shop and Foundry

All patterns should be clearly marked with the pattern number shown on the drawing. For standard patterns or those that are likely to be used frequently, raised letters and figures are the best. The remainder can be marked with a set of metal punches so that a clear impression is left in the wood. The marks should all be located in a position where they are clearly visible, and patterns of a similar nature should bear the marks in approximately the same place, so that no difficulty is experienced in finding them. As these marks will be reproduced in the castings, they will be found useful in other departments, owing to the fact that similar castings will be readily distinguished by the difference in the marking, and if these numbers are used on the detail drawings it will save the use of quite a lot of descriptive matter. The purchaser will also be in a position to quote a few letters and figures, when ordering replacements, which will at once convey to the manufacturer what is desired.

In issuing patterns to the foundry, it will be found useful to place a gummed ticket on the pattern stating the contract number and the number of castings that are required. This method is used in addition to the usual order sheet supplied to the foreman, and is more for the purpose of avoiding verbal instructions to the molder which are often forgotten; it also saves the foundry foreman a great deal of work in fitting a particular pattern to the corresponding item on his order sheet. Sometimes it is necessary to make a pattern do for several sets of similar castings, and in a case of this kind the pattern has to go back to the pattern shop for alteration after the first order is finished. In such cases, a note might be inserted on the gummed ticket reading either "Return to Pattern Shop" or "Return to Store." On completing his order, the molder would rub the ticket off to indicate that the job is finished, and put the pattern in one of two places according to whether it is to go to the store or pattern shop. These places would be kept cleared by the storekeeper on his rounds. As patterns become worn out, the foreman should send written notice to the office giving all necessary particulars, and he should be advised whether it is considered desirable to replace the pattern or not. The records in the drawing office should at once be amended to suit the decision arrived at.

The most desirable plan for obtaining the weights of the castings is to make this work entirely distinct from the operation of the foundry, as there are too many interests involved to enable accurate figures to be obtained, particularly if the shop is on a piecework or bonus basis. The shipping clerk appears to be the right man for this work, as he can weigh up the castings, check up the quantities supplied and, in a general way, make sure that they are all sound. The result of his work will go through the office in the usual course, but a duplicate sheet of the weight of each casting should be made, and this will go direct to the drawing office so that the necessary entries can be made without delay.

The Pattern Store

It is desirable for the work of finding and storing the patterns to be done by one man, as there is a possibility that two or more men would not put the same interpretation on the same marking, and one man will generally be able to say from memory whether the pattern required is to be found in

the store, foundry or pattern shop. An "understudy" can be employed if the size of the place warrants it, but one of the men should be made responsible for the custody of the patterns. Most stores are arranged with tiers of shelves of various kinds, and it is suggested that metal plates or boards, marked with the letter of the alphabet representing each division, should be placed in a conspicuous position. If the system is of the double letter type, previously mentioned, the top shelves would be used for the smaller patterns and the lower shelves for patterns of larger sizes. The largest patterns may be placed on the floor or leaned against an adjacent wall. Each of the shelves should be marked with the small letter indicating the style of the pattern, and it ought to be quite a simple matter to find any pattern that is required at a moment's notice if the men are to be relied upon to do this conscientiously. Unless core-boxes are "specials" for a particular job, they should all be stored together according to their size and shape, as it is often possible to use the same core-box on a great many patterns. Special core-boxes should be stored away as part of the pattern and marked with the same number. The drawing office is too often at fault with regard to the necessity of making new core-boxes, as it is frequently possible to make slight variations in the design in order to utilize an existing core-box. If the particular work warrants it, the expenditure of a little time and trouble on the registration of core-boxes in a similar way to that outlined above would be the means of effecting quite a large economy.

* * *

BRITISH VIEWS ON PUBLICITY

All the world is akin, and apparently the experience of our British friends with those who have mechanical information to give out, is not very different from that sometimes met with on this side of the pond. In the good old days, says the *Practical Engineer*, a manufacturing firm would have thought it sheer madness to communicate to the general public any technical information acquired as the result of tests, and it was only when the information had ceased to have much value in the way of being something new that it was given out for popular consumption. This idea of the fitness of things still prevails in some old-established machine shops, and it is not an infrequent occurrence for a would-be contributor to say, "It's more than my job's worth to write for the technical press." These old firms will readily send you a photograph of a machine and tell you that it has ball bearings, forced lubrication, massive base of box form, eight speeds, power feeds, etc., etc., all of which may mean something or nothing, but to suggest that a few sectional views would be of greater value would cause serious misgivings as to whether you were not, indeed, a spy about to encompass the firm's ruin by stealing its trade.

One readily admits that there are many processes of manufacture which have been evolved at great expense, and which it would be bad policy to give to rivals; but so far as the products are concerned—that is, the machines themselves—it is difficult to see how secrecy can help. The machines must be sold and placed upon the open market. Comparative tests as to production, power consumption, etc., must be made if anything like success is expected. Why, then, should one hesitate to communicate the results of the tests to the world? If they will not stand close scrutiny one can understand that they must be kept in the dark and only used where ignorance prevails. If, however, the figures are fair and *bona fide* and the machine does give the twenty-five per cent increased production with the same power consumption which is claimed, why hesitate to give the reasons and convince even your opponents that they have something to meet?

* * *

DRILLING HOLES IN GLASS

The following method for drilling holes in glass is recommended in a German contemporary: Use a pipe having an outside diameter equal to the hole to be drilled, and squared off at the end. Revolve the pipe at a speed of about 2000 R. P. M. and use emery and water between the end of the pipe and the glass. By this method it is claimed that from 30 to 40 holes of a diameter of ½ inch can be drilled in ordinary thin glass per hour.

BORONIZED COPPER*

As is well known, it has been practically impossible to cast copper which is mechanically sound and of high electrical conductivity, on account of the porous metal that is obtained. By an addition of boron, however, this can be accomplished. Boron has a high affinity for oxygen, nitrogen, and oxygen-containing gases, which cause the difficulty in copper casting. On the other hand, boron has no affinity for copper, and is, therefore, a natural deoxidizer for copper. One per cent of boron suboxide flux (equivalent to 0.08 to 0.1 per cent of boron suboxide) is added to the copper, and a casting that is commercially sound is obtained. Any material that contains boron in a state of oxidation below that of boric anhydride may be used as a flux for copper casting, as, for instance, boron carbide or any alloy of carbon and boron. Owing to this new development, cast copper is rapidly replacing forged copper in many electrical apparatuses. The advantages derived from the use of cast copper are the saving of cost, and also, in many cases, a better apparatus. It is possible, when casting, to eliminate a number of joints which always are a source of loss in efficiency. In the case of current transformers, for instance, a better apparatus is obtained at a reduced cost and a saving of space.

The boron suboxide flux can be added to the copper in a number of ways which are equally good. In the Lynn foundry (General Electric Co.), the pots contain about 125 pounds of metal, and up to the present coal furnaces have been used. The method consists in mixing half of the boron flux to be added with charcoal, putting it on the bottom of the pot and melting down the copper. When the copper has reached the necessary temperature (the copper can be heated too low but not too high) the pot is taken out, the slag skimmed off and the second half of the boron flux added and thoroughly stirred in. After a minute or so the slag comes up to the surface in the form of fused lumps and is skimmed off and the melt is cooled down by adding gates or risers until the proper pouring temperature is obtained. In case a reverberatory furnace is used, the procedure usually followed is to put the flux in the ladle pot on the bottom, pour the copper over it and stir thoroughly. The skimmer and stirrer should not be of iron, as it is difficult to avoid a solution of a slight amount of the iron in the copper and a resulting lowering of conductivity. If done very carefully, the amount of iron would probably be very small, but it has not been found practicable to trust the foundrymen with an iron skimmer or stirrer. Heavy stirrers and skimmers, made of Acheson graphite, have proved sufficiently rigid and are being constantly used in the foundry.

The boronizing process delivers a good metal, and the production of a good casting depends now on the same factors as in other metals. The copper shrinks considerably, about ¼ inch to the foot, and this must be taken into consideration. The casting must be well fed and the sand mold must be rammed very lightly. Where iron molds are used, the iron must, of course, be covered with soot and in some cases it is desirable to use a graphite plate where the hot metal first strikes. When these precautions are taken, no more difficulty is experienced in casting copper than in casting ordinary brass. The electrical conductivity obtained can be as high as 97 per cent of the Mathiessen standard, but in the foundry, using scrap which is not always as clean as could be desired, it is not feasible to guarantee more than 90 per cent conductivity. The mechanical properties are as follows: Tensile strength, 24,350 pounds per square inch; elastic limit, 11,450 pounds per square inch; elongation, 48.5 per cent; reduction in area, 74.49 per cent.

* * *

Cast-iron gages are being used to some extent by manufacturing firms. The cost is much less than steel gages, and when properly made the cast-iron gages answer all practical requirements. The castings are machined approximately to size and are then annealed and again machined to within a few thousandths of the finished size. They are then case-hardened, and ground and lapped to exact size. A cast-iron gage made in this manner is said to be practically unchanging in shape and quite durable in use.

* Abstract of a paper presented before the American Institute of Metals, by Dr. E. Weintraub.

BALL BEARINGS—THEIR CONSTRUCTION AND APPLICATION*

ADVANTAGES OF BALL BEARINGS AND THEIR APPLICATION ON INDUSTRIAL EQUIPMENT

The results of extensive tests which have been performed with the view of determining the relative coefficients of friction for various types of ball, roller and sliding bearings, show a marked superiority of the ball bearing as regards the coefficient of friction. These tests also show that the coefficient of friction for ball bearings varies between very close limits at different loads and speeds, while the coefficient of friction for sliding bearings extends through a very wide range for even small changes in speed or load. The friction in sliding bearings is dependent upon the bearing surfaces, the lubricant, the method of lubrication, the load to be carried, and the pressure per unit of measurement, together with the speed and temperature.

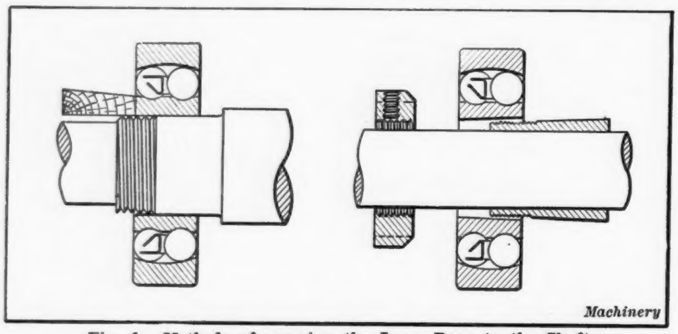


Fig. 1. Methods of securing the Inner Race to the Shaft

It would seem that a roller bearing would be more efficient than a ball bearing, on account of the larger contact surfaces between the outer and inner races, but this is not the case, inasmuch as it is almost impossible to obtain pure rolling motion in a roller bearing. The reasons for this are as follows: 1. It is extremely difficult to commercially produce hardened rollers which are exactly cylindrical. 2. Straight rollers will not carry an end thrust. 3. If there is any tendency for the shaft to twist, or if there is any deflection in the shaft due to the load, there is a tendency for the rollers to twist out of their normal path, and this leaves only a short part of the roller under actual load. To help the roller bearing out, however, there are combinations of annular and thrust roller bearings, but they have not found as wide application as ball bearings have.

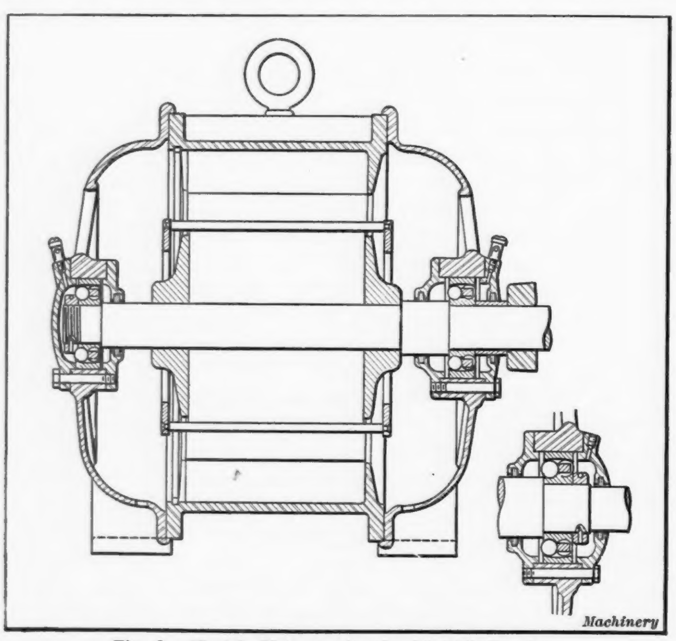


Fig. 2. Electric Motor equipped with Ball Bearings

Ball bearings are used principally for the following reasons: 1. There is less loss of power on account of the lower coefficient of friction. 2. The friction of a ball bearing is independent of the viscosity of the lubricant, or of the temperature thereof. 3. The frictional resistance at starting is very much lower than in sliding bearings. 4. The scraping of bearing linings and fitting them to the shaft is not necessary. 5. There is practically no danger of the bearings running hot. 6. The bearing housings mounting ball bearings are very much shorter than sliding bearings. 7. A ball bearing of proper construction can adjust itself to deformations of the shaft, or strains in the housings.

The reason why a larger ball can take less load than a smaller ball can readily be understood. It is because with an increased volume it is harder to obtain a thoroughly hardened ball. In the matter of speed, the reduction of capacity of the larger ball is due to the tiring out or "fatigue" of the material. Other tests have shown, however, that the tiring out of the steel is caused by the number of load applications and not by the rapidity with which they change. From actual tests with balls, Professor Goodman of the Institute of Civil Engineers in England, derived a formula for the allowable load, in which he took into consideration the velocity of the balls. These tests have shown that the carrying capacity of a ½ inch ball, for example, while it is much greater than that of a ¼ inch ball under static load decreases very much more rapidly than a smaller ball under a given increase in speed for each size.

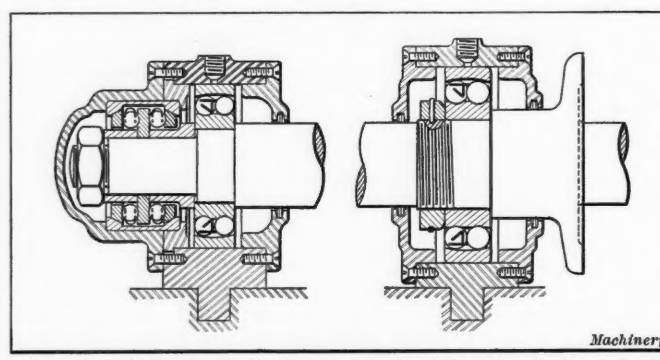


Fig. 3. Ball Bearing Applications for Combined Radial and Thrust Load

It is of great importance for all the balls in a bearing to be finished absolutely spherical, and as nearly of the same size as possible. A large ball in a bearing will take more than its share of the load and thus become overloaded; and at the same time, it will have a different velocity from the smaller balls, which will result in sliding friction either between the ball and the retainer, or if there is no retainer, between the balls themselves. First-class balls can now be manufactured within spherical limits of 0.022 millimeter (0.00008 inch) and are sorted in classes in which the diameter of the balls does not vary more than this amount.

A ball bearing of the right design must comply with the following requirements: The balls must have pure rolling motion, and the races must be so designed that without increasing the friction under load, they give a maximum bearing surface. To fulfill the first requirement, the tangents to the balls at their points of contact with the races must be parallel to the axis of rotation of the balls. This rule, however, is frequently neglected. Efforts have been made to solve this problem by designing ball races with three or four contact points for the balls, but the increased number of points of contact for the balls developed considerable additional friction, and practically all bearings in general use have two point contact.

In the construction employed by the S. K. F. Ball Bearing Co., which is dealt with in this article, the contact surfaces on both the inner and outer races are practically equal, and in addition to this the bearings have the following distinct advantages: Increased reliability because of the fact that the bearings, though made to standard dimensions, have a double row of balls, and because the method of having the outside race spherically ground allows the bearing to automatically adjust itself to any deflection of the shaft or inaccuracy in the mounting or machine frame structure. Furthermore, both rows of balls are loaded evenly, and it is

* Abstract of a paper read by Mr. F. H. Poor before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y.

possible to assemble and disassemble the bearing, if necessary, without destroying it. This last feature may seem extremely simple, yet it is important for the reason that it does away with the slots in the inside and outside rings, and the races are thereby made continuous.

We now come to the discussion of the material from which the bearings are made, which must have the greatest possible hardness in conjunction with toughness after hardening. Furthermore, the steel must be free from slag, and be perfectly homogeneous. Some ball bearing factories are using casehardened races, but aside from the danger of the hardening not being even, there is also the danger in this construction of the races being permanently deformed. It is absolutely impossible to caseharden steel balls because the main requirement to prevent a ball from permanent deformation is through and through hardening. Accordingly, we have to use a material for both balls and races which, in addition to the above-mentioned qualities, has also the quality of being easily and uniformly hardened throughout. The steel must be forged or rolled so that the grain is as close as possible.

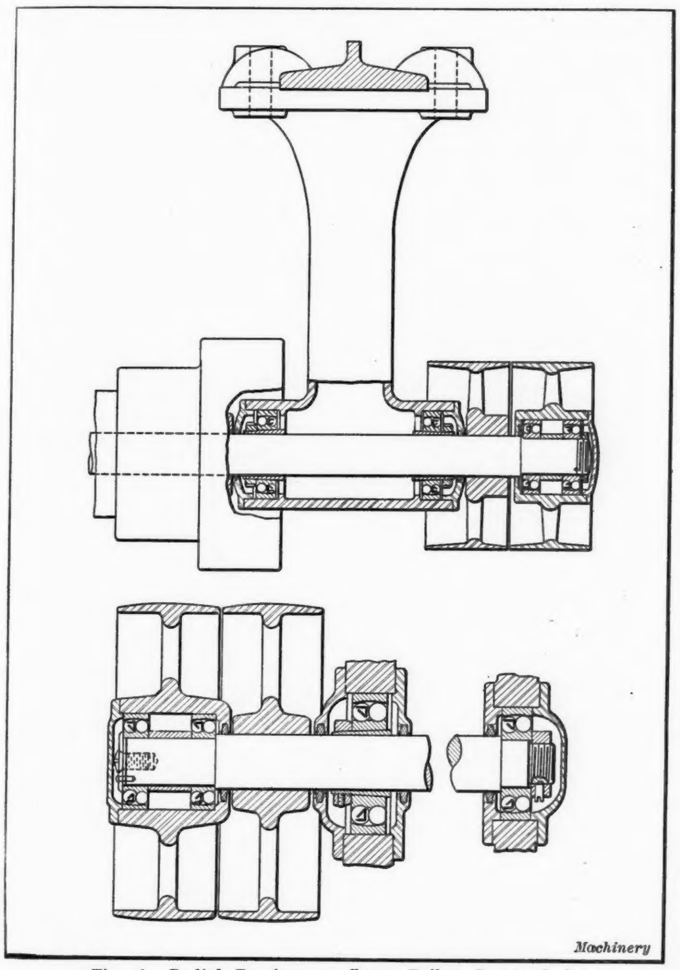


Fig. 4. Radial Bearings on Loose Pulley Countershaft

It may be said that the use of ball bearings in rotating machines is practically unlimited. The following points must be observed in their design if ball bearings are to work at their full advantage. 1. We must consider, as we do in other types of machines, whether the load or speed is variable, and the conditions which are to determine the selection of a heavy enough bearing to meet the machine requirements. 2. The bearings must be mounted so that the outside race cannot squeeze out of true. 3. When the shaft is revolving, the inside race of the bearing should be fastened securely to the shaft, making it practically an integral part thereof. The best means of doing this is to drive the bearing upon the shaft and hold it securely between a shoulder on the shaft and a lock-nut, or by using an adapter sleeve made with a taper to fit in the bearing. By using bushings over a shaft between the bearing inner races, several bearings can be held on the shaft by one nut. In no case should there be any play between the inside race and the shaft because of the possible danger that the ball bearing race will peen down the shaft and ruin it. 4. Only one bearing should be held sideways to take up lateral movement of the shaft, the other bearings being mounted free to move laterally in their housings. This is to allow for elongation or contraction of the shaft, due to changes in temperature or other causes. 5. Ball bearings must be lubricated, although the amount of lubrication required is very small. The lubricant must be chemically neutral, and for general applications, a mixture of vaseline and vaseline oil, or a good mineral oil is recommended. 6. The bearings must, in all cases, be protected from dirt, dust, dampness, and oxygen.

Ball bearings have been applied on electric motors with excellent results, a typical mounting being shown in Fig. 2. For this class of machinery the medium type bearings should be selected, and it is important for all of the bearings to be secured to the shaft on account of the high speed and vibration of the machine. It will be noted that the bearing on the left-hand side has a very small lateral clearance in order that it may take up any possible lateral movement of the shaft. The bearing nearest the pulley is left free to adjust itself, and attention is drawn to the two types of mountings for the bearing next to the pulley. The bearing in one case is held securely against the shoulder by a sleeve between the pulley and the inner bearing race, and in the other case by a locking-nut.

Fig. 3 shows a ball bearing mounting for a circular saw spindle. It will be seen that this application of ball bearings is designed for a combined radial and thrust load. In considering ball bearings of various types of machines, it was not definitely stated that the load conditions are of material importance in determining the proper selection of bearings for different duties. As a general practice in bearings selected for belt driven machines, it is customary to allow a factor of safety of approximately 5, that is, the ball bearings must be selected of such a capacity that the catalogue ratings are practically five times the normal figured load to which the bearings are to be subjected. This factor of safety may seem extremely large, but all of us appreciate that in many cases the tension of the belt is subject to the careless handling of inexperienced workmen, and one cannot foresee to what extent the belts themselves, or the bearings, may be subjected to abuse. In addition, it may be pointed out that belts running at high speeds are usually heavy, and in addition to the pressure to which they subject the bearings, there is every likelihood that pulleys will suffer the constant pound and shock of heavy belt lacing, joints, or the possible accumulation of lumps of grit, sticks of wood, or other materials which may be caught between the belt and the pulley. This is particularly true in train lighting service, woodworking machines, etc.

In the matter of selecting bearings for woodworking machines, we have found that it is necessary to allow a wide factor of safety, particularly on band saws. These saws, in operation, are usually adjusted to a certain tension by means of levers or balancing weights. If the saw becomes heated there is bound to be expansion in the blade, and while the adjusting levers or balance weights may compensate for the increased length of saw, due to heating, the bearings are liable to be cramped after the machine is shut down due to the contraction of the saw blades. On gear drives it is customary to allow a factor of safety very close to three times the normal driving power of the gears, this factor being used for the purpose of allowing for backlash, sudden shocks, or reversals.

* * *

A New York daily newspaper runs a department, presumably for the edification of its readers, called "A Pocket Encyclopedia." Question and answer No. 341 are as follows: "What are the uses of cast iron and steel? Ans.: Cast iron being brittle, is used chiefly for stoves, furnaces, etc. Steel's superior hardness and flexibility renders it useful for making springs, tools, etc!" The idea that because cast iron is brittle it is used chiefly for stoves, furnaces, etc., is interesting but hardly accurate. Newspaper information on technical subjects is quite likely to be misleading, but there is no valid excuse for such flagrant mistakes as this.

ROTATING JIG FOR DRILLING CONNECTING-RODS

An interesting type of rotating or indexing jig which is used for holding connecting-rods while drilling the cap bolt holes is shown in the accompanying illustrations. This jig is used by the Nordyke & Marmon Co. in the automobile manufacturing department of its plant at Indianapolis, Ind., and is

Fig. 1. Drilling Machine equipped with an Indexing Jig for drilling and reaming Six Connecting-rods at One Setting

shown in Fig. 1 set up on a William Gardam & Son, twelve-spindle drilling machine.

The body of the jig to which the connecting-rods *A* are held is heptagonal in shape and is provided with studs which locate the connecting-rods by the holes in their ends. The upper

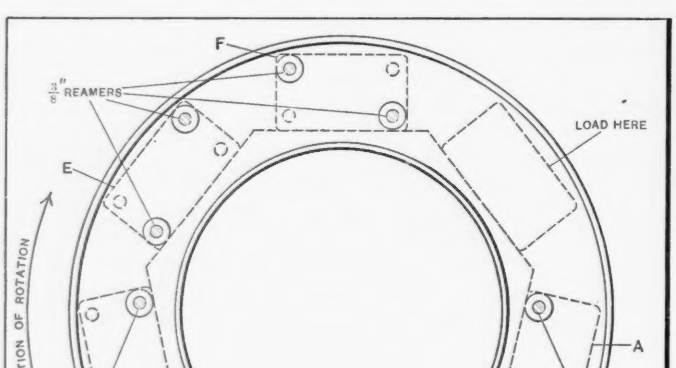


Fig. 2. Diagrammatic View of Bushing Plate showing Arrangement of Drill and Reamer Bushings

studs are threaded to receive the nuts *B*, which, in conjunction with the split washers *C*, clamp the connecting-rods tightly against the heptagon faces of the jig. Bent wire handles *D* are attached to these washers to facilitate their insertion and removal. The lower part of the jig is circular in shape and rests on a circular table to which it is pivoted. The fixture is free to rotate and is locked in the correct positions (seven) by a spring-actuated locking plunger. The operating handle for this plunger is located at the right-hand side of the fixture directly under the "loading position" (see Fig. 2), and is not shown in the illustrations.

The drill bushings for guiding the eight drills and four reamers, *E* and *F*, are held in a circular plate *G*, which, in turn, is fastened by bolts to the top face of the fixture. The arrangement of the bushing holes for the drills and reamers is more clearly indicated in Fig. 2, which shows a top diagrammatic view of the bushing plate. Upon referring to this illustration, it will be seen that while the body of the jig is heptagon in shape, the drills and reamers are in operation on only six connecting-rods. This leaves one position vacant for loading and unloading, allowing these operations to be performed while the tools are at work on the remaining six connecting-rods.

The drilling operation starts at *A* after the jig has been indexed one-seventh revolution. Here two of the 23/64-inch holes are drilled in that portion of the connecting-rod head which when sawed in two forms the cap. At *B*, the remaining two 23/64-inch holes in the connecting-rod are drilled. At *C*

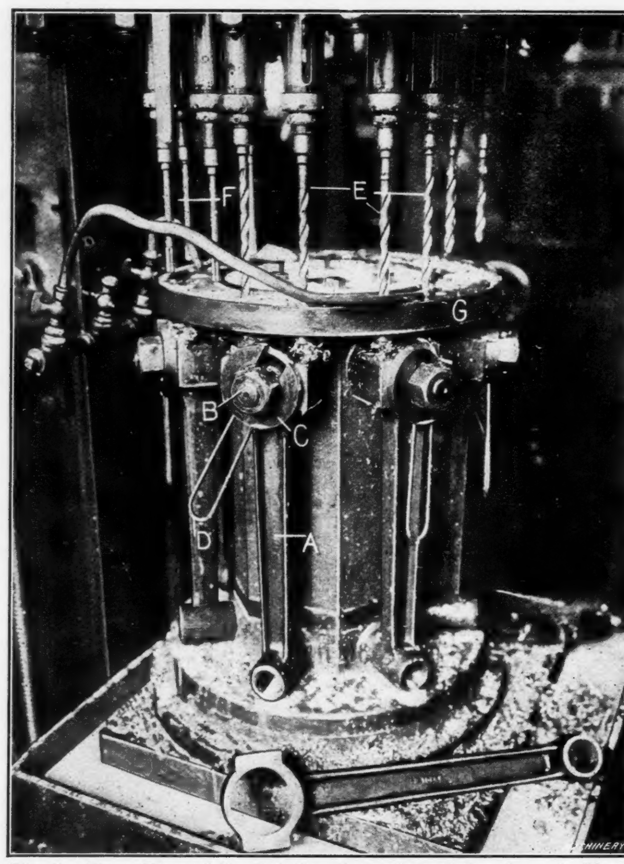


Fig. 3. Closer View of the Rotating Connecting-rod Jig shown in Fig. 1

and *D*, the four 5/16-inch tap drill holes are drilled completely through the connecting-rod head, and at *E* and *F* the holes in the top portion of the connecting-rod head are reamed to 3/8 inch diameter. This completes the drilling and reaming on the six connecting-rods, and while these operations have been described separately, it is evident that in actual operation, the eight drills and four reamers are all at work on the six connecting-rods at the same time. It is also evident that the product obtained from a fixture of this type is considerable; in this case, twelve finished rods are completed per hour, the total drilling depth being 1 7/8 inch, and the material 20 point carbon steel drop-forgings. D. T. H.

* * *

A cheap white metal alloy containing a large percentage of iron has been patented in England. The proportions claimed are as follows: Iron, 50.3 per cent; nickel, 19.2 per cent; copper, 29.1 per cent; aluminum, 1.4 per cent. It is claimed in the patent application that the mixture is almost non-corrosive and white, and that it resists the action of vegetable acids and the atmosphere exceedingly well. If a harder alloy is required, one to two per cent of tin may be added.

MACHINE FORGING—4

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON*

Possibly the greatest advance made of late years in forging is the application of machine methods to the production of engine, machine parts, etc. It is now possible to produce many parts from steel and wrought iron, which a few years ago could only be made from castings. This means a great saving of time and expense, as not only are machine forged parts much stronger than those made from cast iron or steel, but they also cost considerably less to manufacture in large quantities. In the following article interesting examples of different types of upsets, bending and forming operations, etc., will be illustrated and described, together with a general description of the dies and tools used. This will show to a slight extent the remarkable possibilities of the upsetting and forging machine in its present-day development.

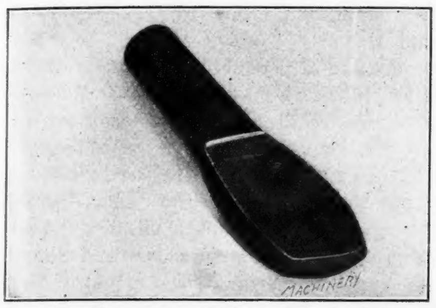


Fig. 46. Extent to which a Bar is flattened between Gripping Dies of "National" Forging Machine before Relief operates

The Upsetting and Forging Machine

The upsetting and forging machine might be considered to a certain extent as a further development of the bolt and rivet making machine, which as was explained in the previous articles, originated almost a century ago. These machines are built much heavier than bolt and rivet machines and are designed especially to meet the demands required of them in the production of difficult-shaped and heavy forgings. For the heavier types of machines the base or main frame, as a rule, is made from one solid steel casting, and a cast-iron base is very seldom used; semi-steel castings, however, are also used to a large extent.

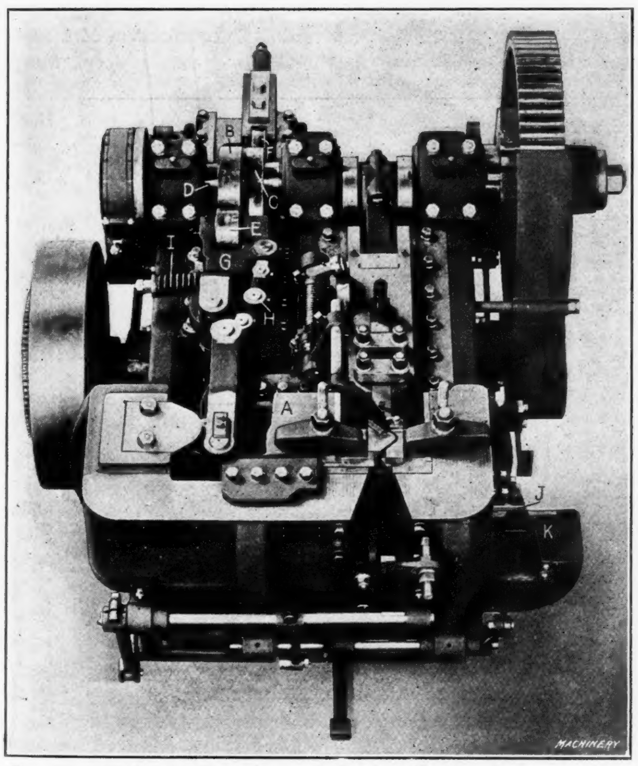


Fig. 47. "National" Upsetting and Forging Machine having a Safety Relief Mechanism for operating the Gripping Dies

A typical upsetting and forging machine designed for heavy service is shown in Fig. 47. The bed of this machine is made from one solid casting of semi-steel and the gripping die mechanism is operated through a by-pass toggle joint of interesting construction. In order to provide against breakage caused by accidentally placing work between the dies, upsetting and forging machines are usually furnished with various safety devices to prevent serious damage to the machine. The safety device in this machine consists of a toggle-joint mechanism for operating the movable gripping die slide.

*Associate Editor of MACHINERY.

As shown in Fig. 47, the gripping die slide *A* is operated by two cams *B* and *C* on the main crankshaft *D*. Cam *B* serves to close the dies which grip the work, whereas cam *C* effects the opening of the dies. These cams contact with chilled cast-iron rolls *E* and *F* carried in the toggle slide *G*. The automatic grip relief is controlled by the by-pass toggle *H* and heavy coil spring *I*. This toggle does not come into play until the strain is such that it would cause damage to the working mechanism of the machine, or in other words until the maximum power required to hold the movable die from springing away, is attained. The relief resets automatically on the back stroke of the machine, thus making a second blow possible without any delay.

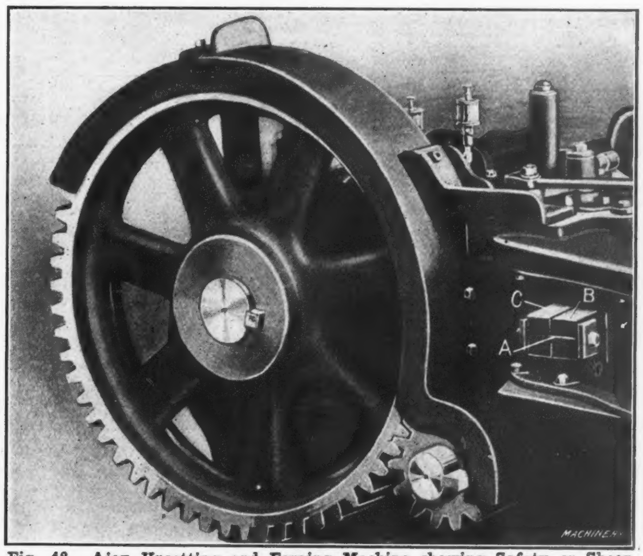


Fig. 48. Ajax Upsetting and Forging Machine showing Safety or Shear Bolt, providing a Safety Relief for the Gripping Dies

Some idea of the enormous gripping pressure secured before the relief mechanism operates is indicated in Fig. 46. This piece, which has been flattened between the opposing faces of the gripping dies, is a 2-inch round bar of 10 to 15 point carbon steel 9⅝ inches long. The flattened portion is 3⅝ inches wide by 5 inches long and 23/32 inch thick. The piece, of course, was heated to a forging temperature before being placed between the opposing faces of the dies and was flattened to the condition shown in one squeeze. This illustrates a fea-

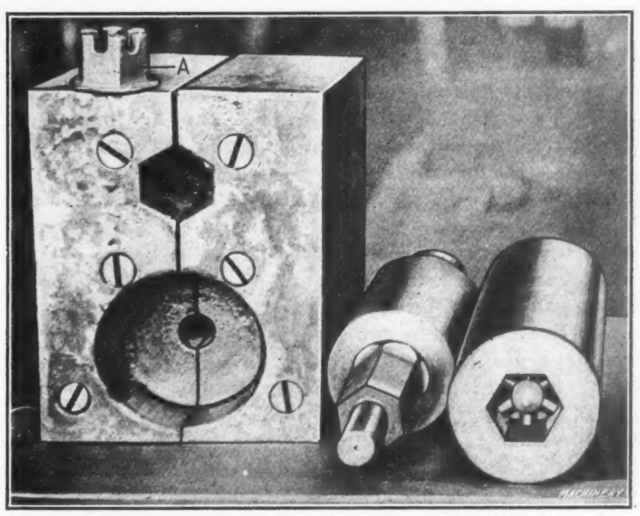


Fig. 49. Dies and Tools used in making a Castellated Nut in an Ajax Forging Machine in the L. S. & M. S. Railway Shops at Collinwood, Ohio

ture peculiar to this type of machine in that it can be used for squeezing or swaging operations, these being carried on between the opposing faces of the gripping dies. In many cases this allows work to be handled that is generally formed or flattened by the side shear *J*, which is operated from the movable die slide, being a continued arm of the same casting.

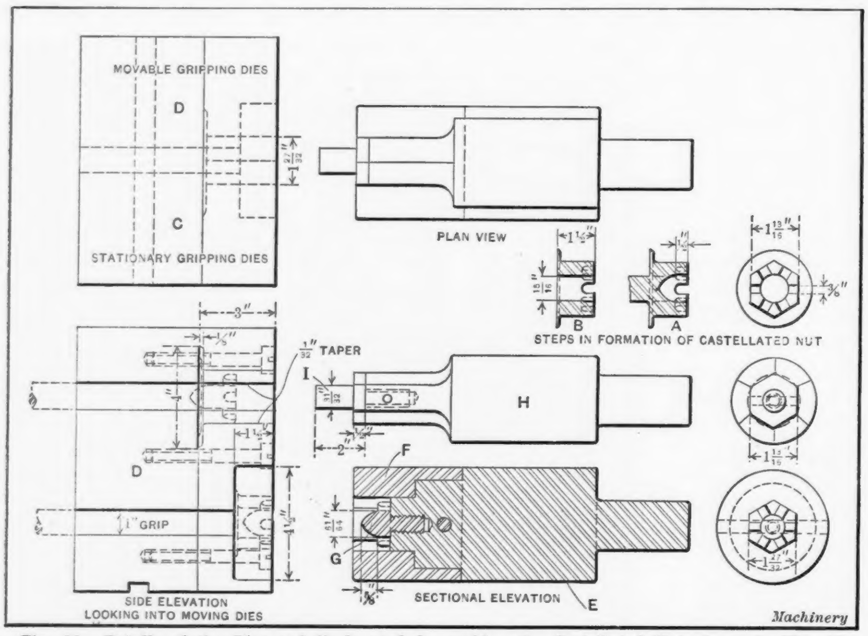


Fig. 50. Details of the Dies and Tools used for making the Castellated Nut shown in Fig. 49

As a rule, the side shear is used for cutting off stock, and it is sometimes used for bending operations, suitable dies or cutting tools being held in the movable slide *J* and stationary bracket *K*, for this purpose.

Another type of upsetting and forging machine in which the working mechanism of the machine is protected from serious injury in a different manner, is shown in Fig. 48. In this machine the safety device consists of a bolt *A* connecting the die slide *B* and the slide *C* operating it. Now when any foreign body intercepts the gripping dies, the bolt *A* is sheared off, thus providing for a positive grip and at the same time furnishing a safety device that protects the working mechanism of the machine against serious injury.

Examples of Upset Forgings—Making Castellated Nuts, etc.

A good example of an upset forging operation which can be handled successfully in an upsetting and forging machine, is the castellated nut shown at *A* in Fig. 49. This type of nut is produced practically without waste of stock in from two to three blows. The gripping dies and tools used are shown in Fig. 49, and also in detail in Fig. 50, where the construction of the tools can be more clearly seen. Referring to the latter illustration, it will be noticed that the dies *C* and *D* are made in two pieces. This is done in order to facilitate the machining operations, and in many cases it enables the dies to be made much cheaper because of the simplicity in construction. These dies are made from scrap driving-axle steel which contains about 60 points carbon, and are hardened in the usual manner, the temper being drawn to a light straw color.

The plunger *E* which upsets the end of the bar into the lower impression in the dies, is made in three parts; this facilitates its construction and the method of manufacture. The body is made from a piece of soft machine steel, on the front end of which a hardened bushing *F* is held by a pin. This, as can be seen, is of a hexagon shape to form the sides of the nut.

Screwed into the body of the punch is a former *G* which is machined to such shape that six "wings" as shown, are formed around its periphery, these producing the castellated grooves in the head of the nut. The former *G* is pointed, and rough-forms the hole in the nut. The top punch which is used for completely punching the hole in the nut and at the same time severing it from the bar is also made from a machine steel body *H* in which is screwed a hardened steel punch *I*, this being prevented from loosening by a pin driven through it.

The method of producing a hexagon castellated nut in a forging machine is as follows: A bar of the required size (which must not exceed the root diameter of the thread in the finished nut) is heated in the furnace to a temperature of from 1400 to 1600 degrees F., depending upon the material, and is then brought to the forging machine and placed in the lower impression of the gripping dies. Then as the machine is operated, the lower plunger advances, upsetting the end of the bar and forming the excess metal into a nut of the required shape. The bar is now quickly removed from the lower impression, placed in the upper impression, and the machine again operated; whereupon the top plunger advances, completing the hole in the nut and attaching the metal thus removed to the end of the bar. These two operations are indicated at *A* and *B* in the illustration. This interesting method of making castellated nuts was secured in the Collinwood shops of the L. S. & M. S. Railway, the dies and tools being designed by George A. Hartline, master smith. The only material wasted in the production of a castellated nut of this character is the slight excess of stock formed

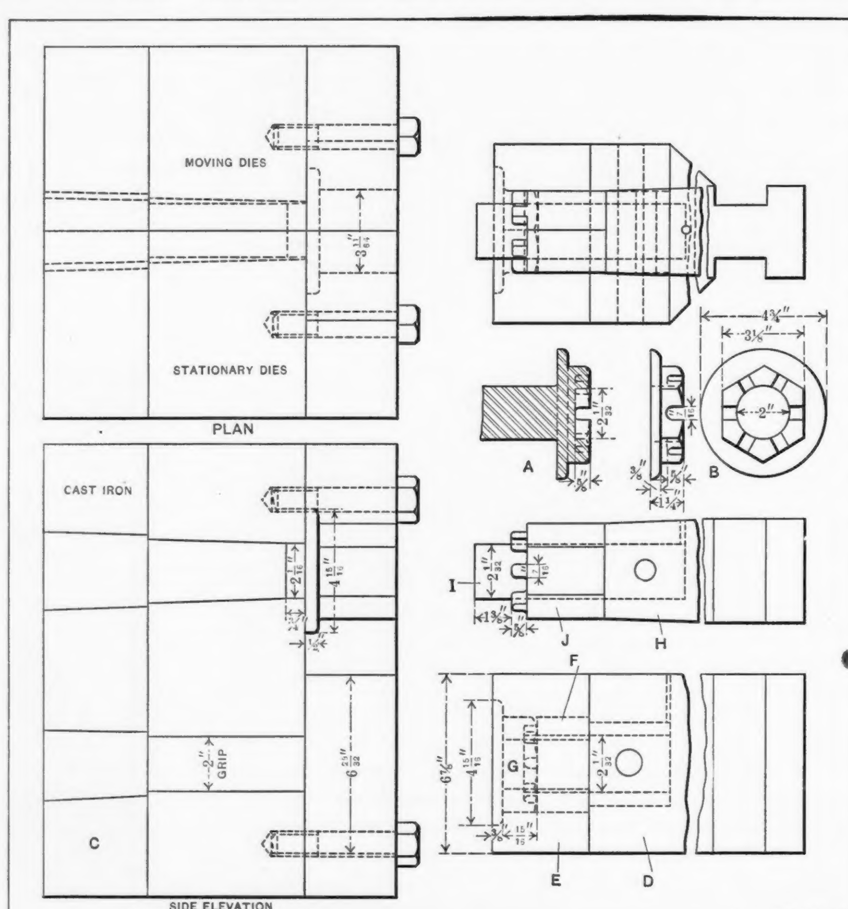


Fig. 51. Dies and Tools used for making a Combination Washer and Castellated Nut which is produced without any Waste of Stock

into a fin, which must be removed, of course, in a subsequent operation.

Another interesting example of castellated nut forging in which the excess metal is used in the formation of a washer

on the nut and thus eliminates all waste of material, is shown in Fig. 51. The construction of the tools here illustrated is almost identical with that shown in Figs. 49 and 50 with the exception of the punches and also the utilization of a cast-iron block *C*, for partly completing the construction of the gripping dies. This part of the gripping dies which is made from cast iron is not used at all as a gripping medium and hence does not need to be made from steel to provide for wear. The lower punch *D* in this case is made from machine steel and is provided with a tool-steel head *E* which is bored out and formed to a hexagon shape. Inserted in this is a sleeve *F* for forming the castellated portion of the nut, in which is fitted a punch *G* for rough-forming the hole in the nut. The upper plunger *H* carries a punch *I* which completely forms the hole in the nut by punching the bar back, and by means of the castellated washer *J* finish-forms the castellated grooves in the nut. The steps followed in the production of this combination castellated nut and washer are shown at *A* and *B* in the illustration. A 2-inch bar of wrought iron is used, and it requires a length of 4 inches to form the nut and washer.

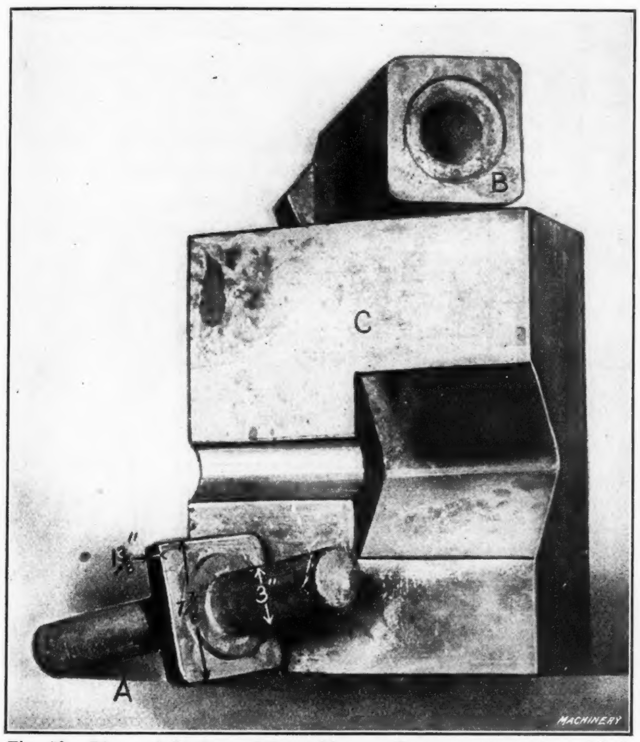


Fig. 52. Dies and Tools used in making an Enormous Upset in a 6-inch Ajax Universal Forging Machine

Dies and Tools used for Making a Locomotive Trailer Pin

The locomotive trailer pin shown at *A* in Fig. 52 represents about the maximum amount of upset which can be satisfactorily made in a forging machine, and in fact, is much greater than that usually recommended as being practical. This example which is supposed to be the largest upset ever made by machine methods was accomplished in the Chicago shops of the C. & N. W. Railway, on a 6-inch Ajax universal forging machine, the dies and tools used being designed by T. E. Williams, master smith. This trailer pin is made from a 3-inch round wrought iron bar 26 inches long, and an excess amount of stock equal to 10 3/4 inches in length is put into the upset in one blow. The dimensions of the upset square flange are 7 7/8 inches across the flats and 10 5-16 inches across the corners by 1 3/8 inch thick. The circular flange is 5 7/8 inches in diameter by 5/8 inch long. After the work is given the first blow with the plunger *B*, a reheat is then taken and the work is again placed between the gripping dies *C*, only one of which is shown. The machine is again operated and the part given another blow which serves to close up the texture of the steel and eliminates the defects caused by the structure of the steel pulling apart during the upsetting operation. The production of this enormous upset gives a slight idea of some of the possibilities of machine forging in making engine parts, etc.

Bending and Forming Operations

The making of ladder treads for freight cars is a good example of bending and forming operations that can be handled successfully in the upsetting and forging machine. Fig. 53 shows three of the steps followed in the production of a ladder tread which is completed to the shape shown at *C* in five operations. Two of these operations, which will not be described in detail, are accomplished in the bulldozer, and consist in bending the ladder tread to its final shape.

The dies and tools used for forming the feet of the ladder tread are illustrated in Fig. 54. The first operation is indicated at *A* and consists in cutting off a bar of 5/8-inch iron to the required length. This is heated on one end, placed in the lower impression in the gripping dies *G* and *H* and given a blow by the plunger *I* which forms the end of the rod into the shape shown at *B*. In this operation, the stock is upset just far enough so that it will not buckle in front of the dies.

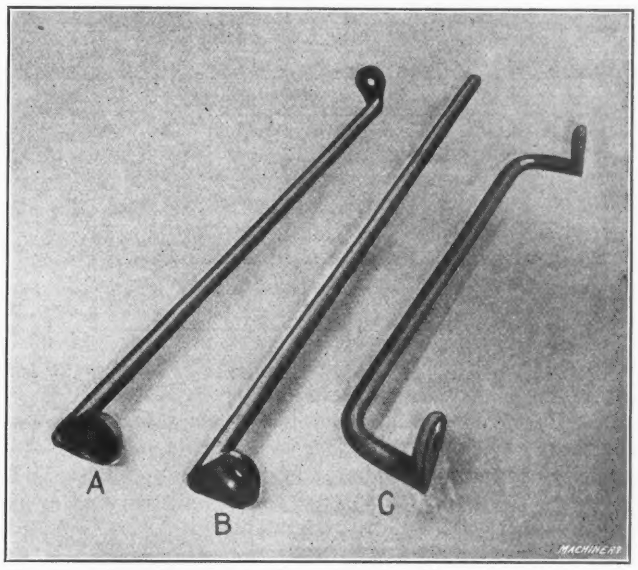


Fig. 53. Three Steps in the Formation of Ladder Treads for Freight Cars, accomplished in a "National" Forging Machine

The second operation bends and forms the stock back into a solid forging as indicated at *C*, this being accomplished in the second impression in the gripping dies in conjunction with plunger *J*. The final forging operation, the result of which is shown at *D*, completes the foot, the upper impressions in the dies being used for this purpose; these are made the exact shape of the foot, and the plunger *K* has a pin in it which punches the hole in the foot to within 1/16 inch of passing through the 9/16-inch stock. The final operations which are performed in a bulldozer or other bending machine consist in bending both ends of the tread to the required shape. This requires two operations, which are indicated at *E* and *F*, respectively. Before the final bending, the forging is taken to an emery wheel to remove the burrs formed when forging the feet.

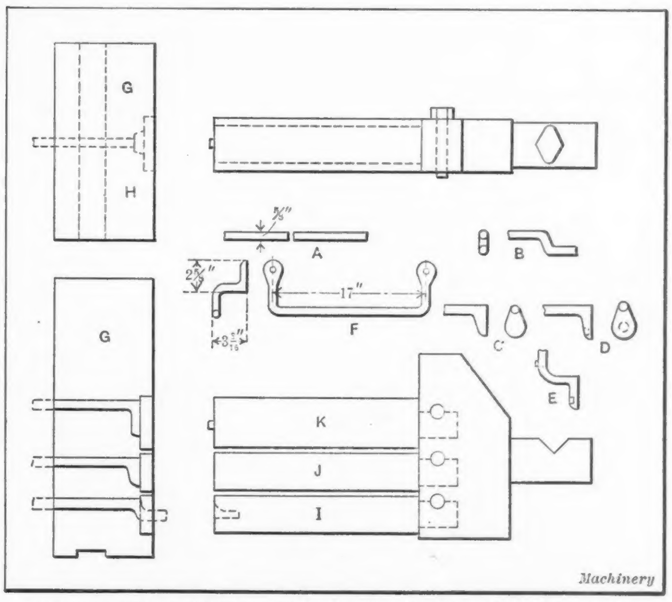


Fig. 54. Dies and Tools used in forming the Feet of Ladder Treads

The eye-bolt shown in two stages of its formation, at *A* and

B in Fig. 55, is another example of a bending and forming operation accomplished in a forging machine. This eye-bolt is made from a 1⅜-inch round wrought-iron bar, and is completed in two blows in a 3-inch Ajax forging machine, using the dies

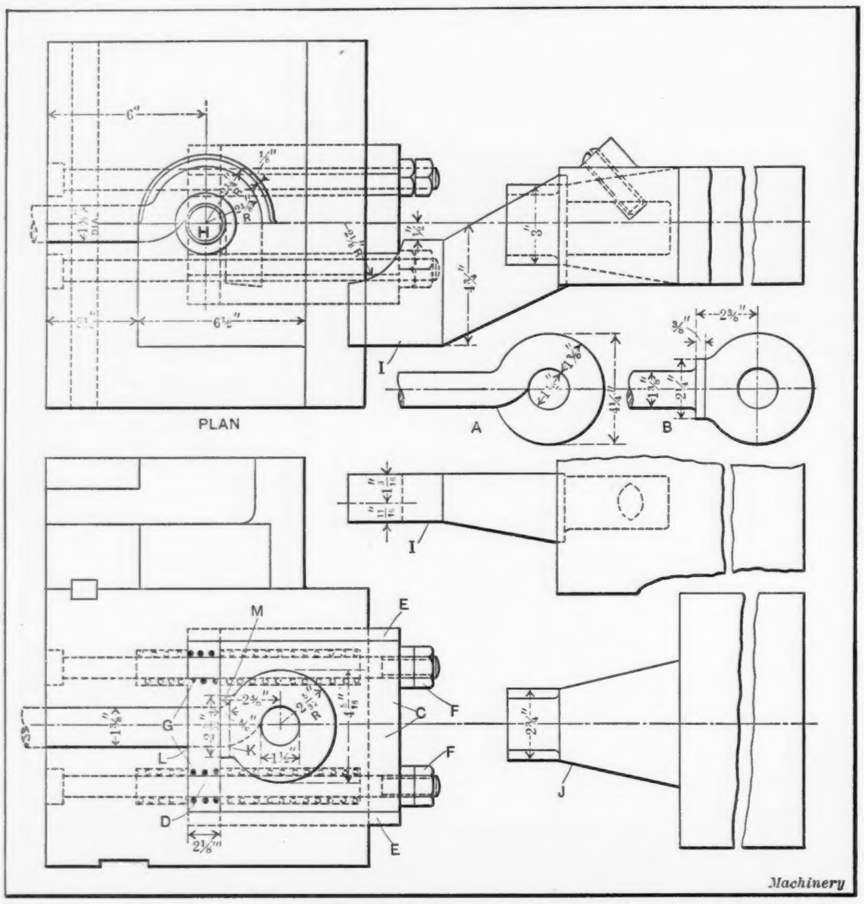


Fig. 55. An Interesting Set of Dies and Tools used in a 3-inch Ajax Forging Machine for forming Eye-bolts in Two Blows

and tools illustrated. The construction of the gripping dies is rather unusual and hence interesting. The lower impression in the dies consists of two movable members *C* which slide on four rods *D* and are provided with tongues *E* which fit in corresponding grooves in the movable and stationary gripping dies. The pins, of course, act as mediums for holding these sliding members *C* in the gripping dies. The blocks *C* are kept out against the adjustable lock-nuts *F* by open-wound coil springs *G*.

The method of operation is as follows: The stock is first heated for a portion of its length to the correct temperature, then placed in the upper impression of the stationary die, being located in the correct endwise position by the stop of

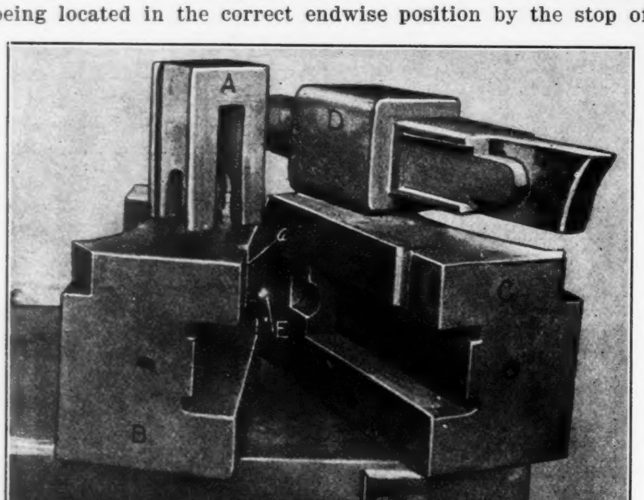


Fig. 56. Dies and Tools used for forming a Driver Brake Adjusting Rod Block in a 5-inch Ajax Forging Machine

the machine. The machine is then operated and when the movable die closes on the work, it grips it and at the same time forces the heated end of the stock around the pin *H* held in the stationary die. Just as soon as the dies close tightly on the work, the punch *I* comes in contact with the bent end of the bar and forms it around the pin *H*, bending the work into the shape shown at *A*. The dies now open and the work is removed and placed on the pin forming the center portion of the impression in the blocks *C*. The machine is again operated and as the dies close, the ram *J* advances and forces the blocks *C* forward, carrying the "eye-end" of the work along with it.

Now as both parts of the bar—"eye-end" and body—are rigidly held in the gripping dies and movable blocks *C*, it is evident that the part of the bar between the points *K* and *L* must be upset. The result of this displacement of the stock causes the formation of a shoulder on the bar at the base of the eye, formed by the circular impression *M* in the blocks *C*. The amount of stock required to form the boss at the base of the "eye" is governed by the position of the lock-nuts *F*. The ram *J* and gripping dies are made from steel castings. The four compression springs *G* are 10¾ inches long when extended, of ¼ pitch, and 5/32 inch diameter wire is used, the outside diameter of the spring being 1 3/16 inch.

Dies and Tools for Forming a Driver Brake Adjusting Rod Block

A difficult forming operation accomplished in the forging machine is shown in Fig. 56. The part *A* which is called a driver brake adjusting rod block is used on freight cars and is produced by the L. S. & M. S. Railway Shops, at Collinwood, Ohio. It is made of wrought iron and is completed in two blows in a 5-inch Ajax forging machine. The method of procedure in making this piece is to first cut a piece of rectangular bar iron to the required length and then bend it into a U-shape in the bulldozer. It is then taken to the furnace where it is heated to the proper temperature, and a "porter" bar which is simply a bar of iron, about ¾ inch in diameter, is also heated. This is stuck to the bent piece (which is to form the block) and the latter is placed between

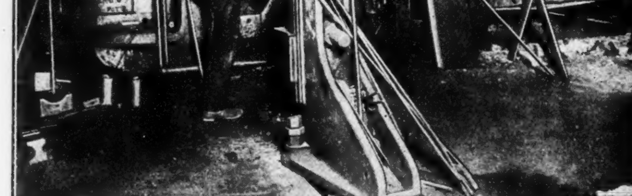


Fig. 57. 5-inch Ajax Forging Machine at Work in the Collinwood Shops of the L. S. & M. S. Railway, set up for making Coupler Pocket Filling Blocks for Freight Cars

the gripping dies, the bar being used simply as a means of handling. The dies shown at *B* and *C* are provided with half-round impressions shown at *a* and *b* through which the "porter" bar projects. As the machine is operated, the front end of plunger *D* which, as can be seen, is of shear shape, cuts off the "porter" bar and forces the bent piece into the impressions in the gripping dies. While the piece is still held in the dies, the machine is again operated and the work given a second blow this, of course, all being accomplished in the one heat. The round ended plug *E* at the end of the impression in the

stationary die forms an impression in the end of the block and serves as a spot for a subsequent drilling operation.

Fig. 58 shows a forging accomplished in practically the same manner as that illustrated in Fig. 56. This part, which is called a coupler pocket filling block, is used on a freight car and is made from scrap arch bars cut up into pieces of the desired length. These pieces are first formed into a U-shape in a bulldozer and are then brought to the furnace shown to the right in Fig. 57. Here they are heated to the desired temperature, then gripped with the tongs and placed on the shelf of the back stop *A*. The forging machine operator then by means of a "porter" bar, as before, lifts the piece from the shelf and places it between the gripping dies, where the forging is given two blows and then thrown down in the sand to cool off. Fig. 58 gives some idea of how this coupler pocket filling block is produced. The piece of arch bar which has been formed to a U-shape in the bulldozer still forms the end of the block, the sides or webs being formed by bending in the arch and lapping up the open ends. This can easily be seen by referring to the piece *A* in the illustration, where the joint formed in this manner is clearly shown. The burrs formed on these pieces are removed in a subsequent operation.

Fig. 58. A Heap of Finished Forged Coupler Pocket Filling Blocks

* * *

DEPOSITING COPPER ON PLASTER OF PARIS

A method for depositing copper on plaster of Paris is described in the *Chemical News*. The plaster article is thoroughly dried and then warmed, after which it is introduced into a bath of melted paraffine, heated to about 150 degrees F. The article is then removed and allowed to cool. The paraffine permeates the plaster and makes it waterproof. The article is now coated with a thin layer of collodion, diluted with ether and alcohol and allowed to dry. The surface is then coated with electrotypers' plumbago, the copper wires for conducting the electricity are attached, and a second coating of plumbago is given it. The plaster article is now placed in a ten per cent solution of aluminum sulphate for a few minutes, and then in the copper plating bath made of sulphate of copper and sulphuric acid. This solution should contain from five to eight per cent of sulphuric acid. A current density of one ampere to each sixteen square inches is used at three volts. Aluminum sulphate is of assistance in producing a rapid copper deposit all over the surface.

* * *

THE PRECISION LATHE AS A GENERAL PURPOSE MACHINE TOOL

The bench lathe is generally regarded as a machine tool adapted only for light turning, boring, milling and grinding, and one particularly suited to work required to be finished within close limits—hence the common designation of "precision" lathe. Of course this generalization is not strictly true, inasmuch as there are engine lathes made with short legs and pan for use on benches. These are lower-priced than regular bench lathes of the precision class and are not regarded as being so well suited for finishing small parts with speed and accuracy as the special type of lathes.

The fact that the so-called "precision lathe" is a machine tool of wide adaptability which can be made highly efficient for certain classes of manufacturing as well as for a wide range of tool-room work, is not as well appreciated as it should be. The factors in favor of the bench lathe are compactness, light weight of moving parts and the possibility of running the spindle at high speeds continuously without serious heating. The high speeds with the cuts and feeds possible with the best high-speed steel tools enable an expert operator to show a chip production in a day's work that compares favorably with the average production of a fourteen-inch or sixteen-inch engine lathe working on much heavier pieces.

The modern precision lathe can be employed efficiently in the tool-room for such work as making jig bushings. This is a job requiring accurate turning and boring, grinding after hardening, and lapping as a finishing operation. Other jobs such as making small hardened and ground steel washers can be handled on a bench lathe fitted with a grinding attachment.

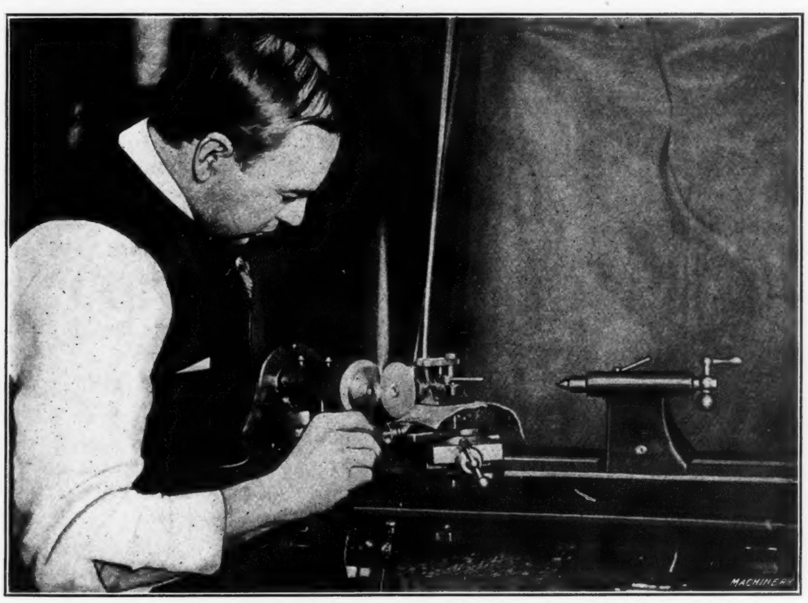


Fig. 1. Cincinnati Precision Lathe being used as a Grinding Machine on Hardened Steel Washers

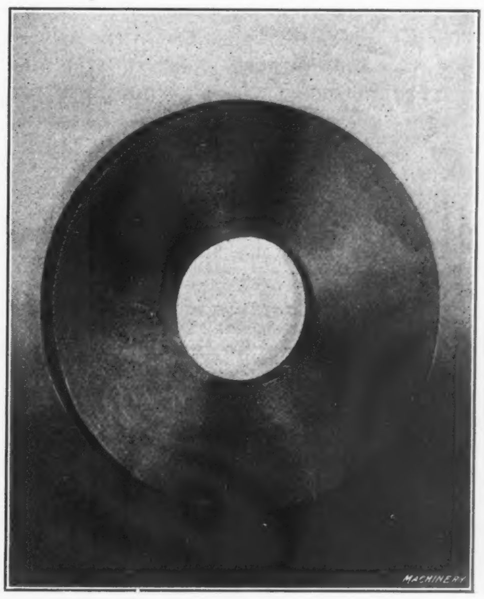


Fig. 2. Hardened Steel Washer ground on Precision Lathe

The illustration Fig. 1 shows a Cincinnati precision lathe being used as a grinding machine for finishing some hardened washers which were turned and bored on this machine. The washers are about 2½ inches outside diameter, the hole diameter being ⅞ inch. The lathe has a swivel headstock which may be readily set for face grinding at such positions as are most convenient for the operator. Fig. 2 shows an example of grinding done on a hardened washer. The claim is made that with the spindle construction and bevel gear drive employed, unusually smooth work can be produced—that a surface for most practical purposes equal to a lapped surface can be ground in a fraction of the time required for grinding and lapping with the common means and methods.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

MACHINING THIN WORK WITHOUT DISTORTION

In the everyday process of manufacturing, the problem frequently comes up of machining a thin metal pot or shell of some sort without undue distortion. When the work is of small size like that shown in Fig. 1, for instance, it is not especially difficult, but when the diameter runs up to twenty-five or thirty inches, and the thickness of the wall still remains one-eighth inch, or thereabouts, the problem is more serious.

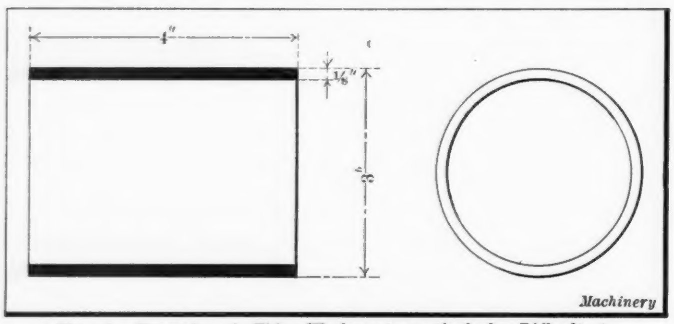


Fig. 1. Example of Thin Work not particularly Difficult to machine accurately

Fig. 2 shows an annular forged steel ring, from which the automobile clincher rim shown in Fig. 3 was to be machined, and it will be noted that the thickness of the shell is only one-eighth inch when finished. This piece was successfully handled as follows: The rough-forged ring was first placed on the bed of a drill press, and a one-half inch hole drilled at *A*, Fig. 2, after which a short piece of steel was inserted to act as a driver.

The work was then placed with the driver side down on the table of a Bullard vertical turret lathe, and the chuck jaws brought into contact at *B*, allowing the driver to thrust against

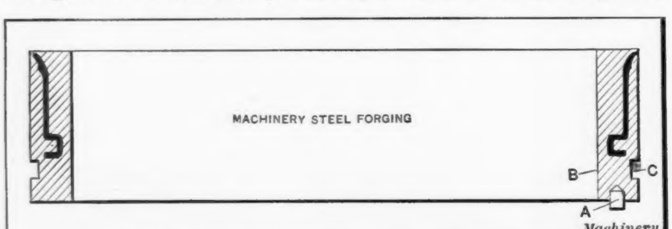


Fig. 2. Forged Steel Ring for Automobile Clincher Rim

the side of the jaw. Using the main head and side head simultaneously, the work was roughed out to within about one-sixteenth inch of the finished size and a groove or shoulder cut at *C*. The tension on the jaws was then released to a minimum, and hold-down straps inserted in the groove, bolting them down in the table T-slots, and allowing the driver to do practically all the work. After this had been done, it was a simple matter to complete the turning and inside finishing to the required dimensions, and finally cut off just above the straps, leaving the piece free from distortion.

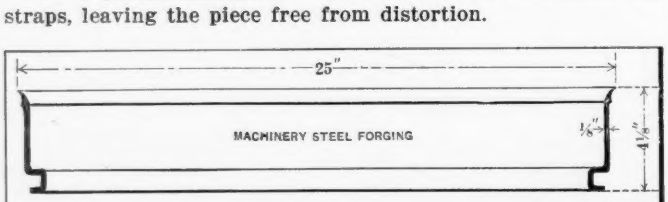


Fig. 3. Automobile Clincher Rim finished without Distortion

This particular job consisted of four pieces only and therefore did not warrant the expenditure of much money in the line of special holding devices. Shortly after this job was done, however, a lot of one hundred pieces came along, and it was deemed advisable to adopt another method of handling in order to facilitate production. A set of special jaws, as shown in Fig. 4, is the main feature of the improved method. The hole *A* extends through the body of the jaw, and permits a floating action to the hook-bolt shown in the illustration.

In using this method, the face of the jaw *B* was brought up lightly against the work until it was just possible to detect its contact, after which the hook-bolts were brought to bear against the inner surface and securely tightened with a wrench. The freedom from distortion in this method of holding naturally permitted more rapid removal of stock, with a resulting gain in production, and while not by any means a new idea it is one not frequently made use of.

Bridgeport, Conn. ALBERT A. DOWD

THREE-DISK METHOD OF LOCATING HOLES

The foreman toolmaker of a shop engaged in the manufacture of a line of small machinery requiring the greatest accuracy, recently showed the writer how he located holes in jigs by the use of three disks of such diameters that when they were placed touching one another, their centers would be at

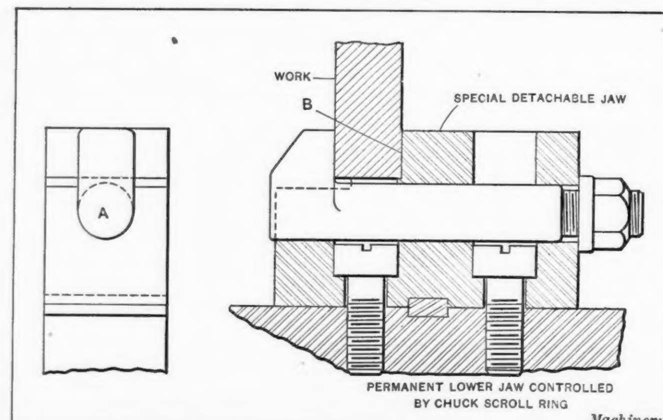
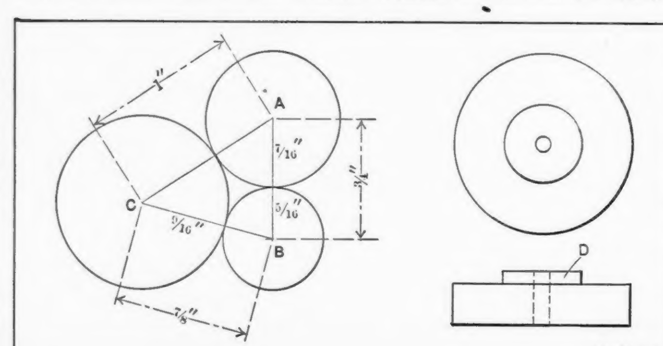


Fig. 4. Special Jaw used on Boring Mill to clamp Ring without distorting it

the required distances. There is nothing new about the use of this method, either on work held on the lathe faceplate, in which case the disks have hubs *D* for the indicator, or for cruder work which is handled on the drill press where each disk has its central hole large enough to hold a jig bushing to guide the drill.

The only novelty of the explanation of this method which was given by the foreman lay in his statement that he could not use it as often as he wished because of the labor involved



Three-disk Method of locating Holes and Detail of Disk

in determining the diameters of the required disks. In proof of this statement he produced a mass of "algebraic looking" calculations. As a matter of fact, the problem is usually so simple that nine times out of ten it can be solved mentally. Referring to the case shown in the accompanying illustration, it will be obvious that the radius of disk *A* must exceed one-half of the distance *A-B* by one-half of the difference between the distances *C-A* and *C-B*. This also gives the required diameters of disks *B* and *C*. For the case shown, it will be seen that the required radius of disk *A* is 7/16 inch, the radius of disk *B* is 5/16 inch and the radius of disk *C* 9/16 inch.

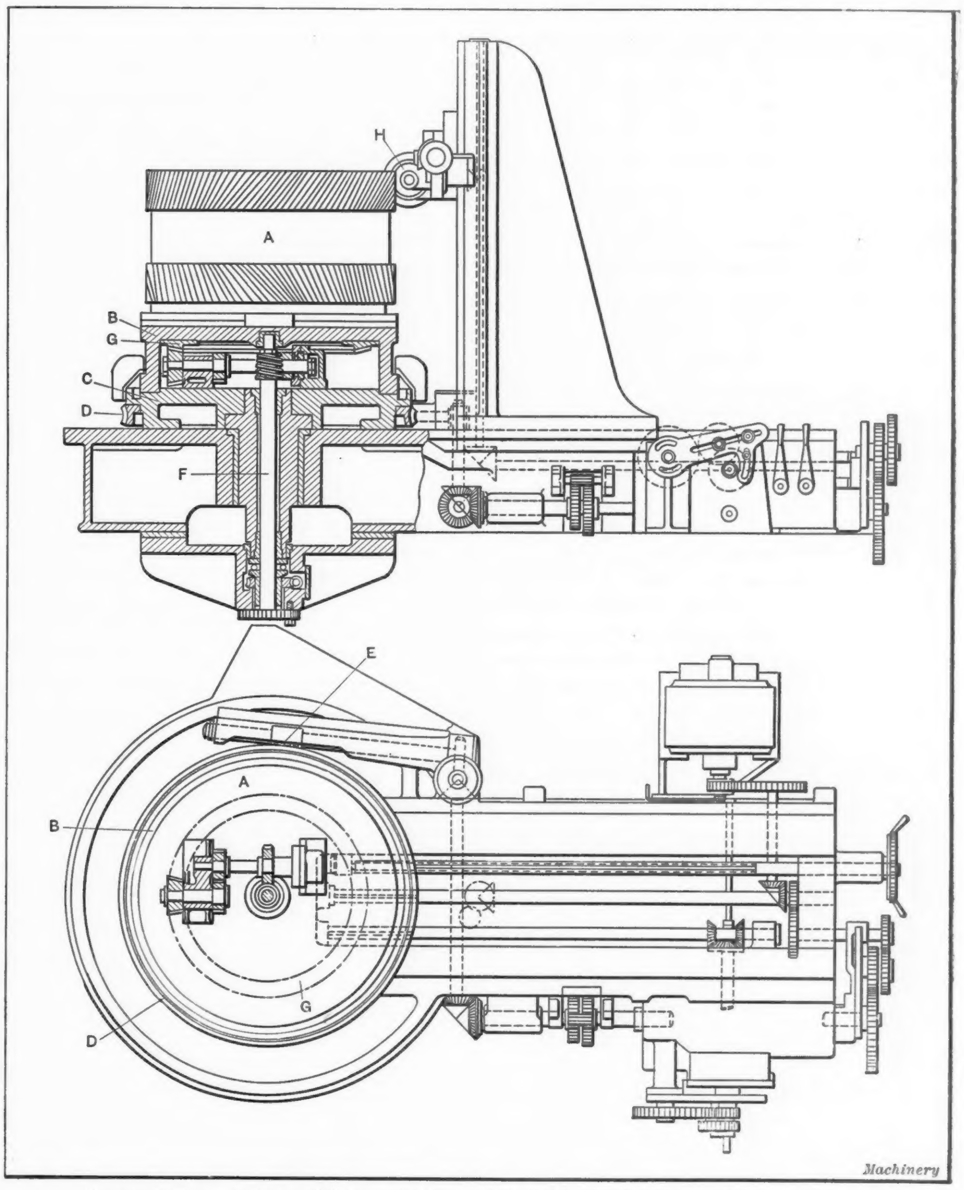
New London, N. H. GUY H. GARDNER

IMPROVEMENT IN GEAR CUTTING

The English engineer, Sir Charles A. Parsons, has developed an ingenious and scientific method of cutting the teeth of gearing used in connection with steam turbines for the propulsion of ships. For efficient operation, turbine speeds are much higher than the most suitable speeds for propellers and, consequently, some form of reduction gearing should be used between the turbine and the propeller. Double helical gearing is usually employed to accomplish the speed reduction because high speed and smoothness of action are essential, but even with this type of gearing considerable noise has been experienced. Careful investigations were made by Mr. Parsons to determine the causes producing noise, and its source was traced to the large worm-wheel which rotated the table of the gear hobbing machine. This worm-wheel is known as the "parent" gear.

By means of the hobbing machine tooth-faces are automatically and continuously generated by a hob which is nothing more than a worm with slots running lengthwise to form cutting edges. The gear to be cut is mounted on a horizontal table which is rotated by proper change gears. The hob cuts by its rotative action and must be set at the proper angle to the axis of the gear. After making careful measurements, inaccuracies of the cut gear were found to occur at the same time as those of the parent gear and at definite intervals, the errors lying in planes through the axis of rotation. The idea occurred to Mr. Parsons that if the speed of rotation of the work were given a small but steady advance in relation to that of the table driven by the parent gear, these errors, instead of lying in planes through the axis of the gear wheel, would lie in spirals around it. Consequently, the periodicity of the errors would be destroyed.

In order to obtain this result, an existing type of gear hobbing machine was fitted with a secondary table which was mounted on the original table. The secondary table is driven by suitable gearing at a speed of one per cent faster than that of the original or lower table, thus giving it a creep. The original table is driven through the parent wheel. The main worm operating the original table was then driven at one per cent less speed, so the work was given practically the same rotational speed as before the creep was introduced. Later developments have led to the conclusion that a creep of five per cent might possibly be better.



Improved Type of Gear Hobbing Machine which eliminates Inaccuracy due to Parent Gear

The general arrangement of the gear hobbing machine, fitted with the creeping table, is shown in the illustration reproduced from *Engineering* (London), March 14, 1913. The work *A* is mounted on the secondary or creeping table *B*, which, in turn, is mounted on the original or lower table *C*. The worm-wheel or parent gear is shown at *D* and is driven by the worm *E*. The creeping table is driven by means of the vertical shaft *F*, which transmits its motion through a worm and wheel to suitable gearing engaging with the circular rack *G* on the under side of the secondary table. The hob for generating the teeth is shown at *H*.

The most important effect of this method of cutting gears is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing. At the same time the errors themselves have been considerably reduced. Gears cut by Mr. Parson's new method have been tried and found to run very quietly.

Scranton, Pa. T. W. Holloway

TESTING THE HARDNESS OF METALS

An important factor seems to have been overlooked in Mr. H. M. Nichol's method of testing the comparative hardness of metals, which was described in the April issue of Machinery. It appears to the writer that the results obtained by this method are dependent upon the "personal factor," and he would like to know what regulates the tightness to which the vise is screwed up. Suppose, for instance, that twice the power is exerted by the man in screwing up the second piece —what happens? Certainly a deeper impression will be made, and this may affect the accuracy of the results of the test. If, however, the position of the lever or the angle to which the vise screw has been turned is observed and subsequent pieces are tested by tightening the vise to the same point, it would then appear that the test should offer a fair indication of the comparative hardness of the different metals which were tested. The following outlines the reason for this assumption. 1. The vise screw is in effect a powerful spring, and by always tightening it up to the same point, the same amount of tension will be produced. 2. The reaction of this tension, which is effective while the vise is being screwed up, will vary with the hardness of the material which is being tested, the ball making a deeper impression in soft than in hard material. 3. The comparative tests must be made on pieces of the same thickness or else allowance must be made for variations in thickness. In making

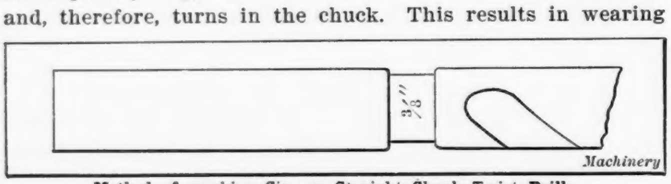
such allowance, it would be necessary to use a vise fitted with a precision screw or some other means of measuring the amount which the vise is screwed up after the ball has just been engaged.

It appears to the writer that this method, at best, affords too many loop-holes through which errors may be introduced. A much more reliable test may be employed in any shop where there is an arbor press fitted with a pressure gage. In using such a machine, the test sample may be put on the table and the ball pressed down into it until a specified pressure is indicated. The ball could be supported in a depression in a piece of hardened steel provided for the purpose. In testing all pieces under the uniform conditions obtained in this way, the writer believes that more reliable results would be obtained.

Manchester, England. FRANCIS W. SHAW

NUMBERING MACHINERY AND TOOLS

I was interested in reading Mr. James E. Cooley's article on "Numbering Machinery and Tools," which appeared in the April issue of MACHINERY. There is another case of very bad practice in numbering tools which was not touched upon in this article, *i. e.*, of placing the size of a straight shank drill on the shank. The trouble in this case is not with the size of the numbers that are used, but with their location. It frequently happens that a drill is not held tight enough and, therefore, turns in the chuck. This results in wearing



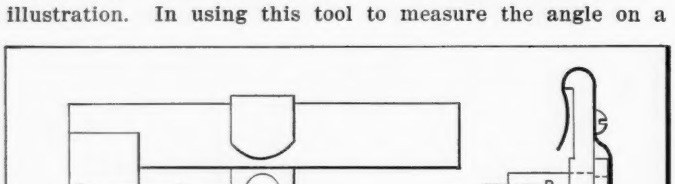
Method of marking Size on Straight Shank Twist Drills

the shank down sufficiently so that the numbers are no longer legible. This is a difficulty that could be avoided by providing each drill with a small central groove between the shank and the twisted section, and placing the numbers representing the drill size in this groove. This practice would save a lot of time which is now spent in measuring and remeasuring drills, where the number has become so badly worn that it cannot be read with any degree of certainty.

Detroit, Mich. HERMANN MUELLER

TOOL FOR MEASURING ANGLES AND TAPERS ON SMALL WORK

The tool illustrated in this article is simply a "sine protractor" with the buttons *A* and *B* set exactly one inch apart. These buttons are carried by a spring clamp which is secured to the blade of a small square in the manner shown in the illustration. In using this tool to measure the angle on a



Sine Protractor for measuring Angles and Tapers on Small Work

piece of work, the latter is set between the stock of the square and the two buttons of the sine protractor. A micrometer is then used to measure the distance of the buttons *A* and *B* from the bottom of the stock of the square. As the buttons are exactly one inch apart, the difference of the two micrometer readings gives the sine of the angle, and by referring to a table of sines the angle can be obtained. One of the particularly useful applications of this tool is in measuring the angle of tapered round pieces which, as is well known, cannot be accurately done with a vernier protractor because the smaller part of the taper drops further into the grooved blade than the larger part.

New London, N. H. GUY H. GARDNER

FAILURE OF A JAW CLUTCH

An engineer once told the writer that he had never yet seen a case in which the dimensions of a part that failed figured out to show it capable of carrying the required load. One must sometimes have a failure or two, however, before the proper method of figuring is learned, as a part of adequate strength may fail because some unforeseen condition arises. When this "unforeseen something" could have been anticipated the designer is at fault, and the "man on the job" who observed the failure is more than likely to come out with some severe criticism, although he himself did not anticipate the occurrence of the condition until it actually happened.

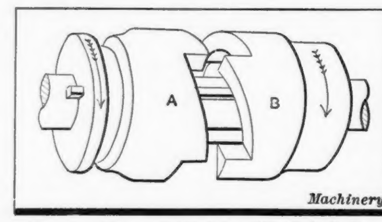


Fig. 1. Type of Clutch with Spiral Jaws that caused Levers to be broken

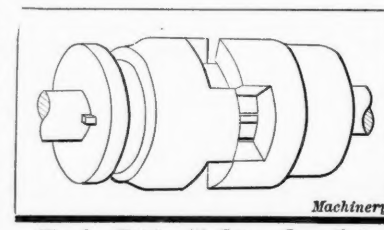


Fig. 2. Clutch with Square Jaws that eliminated the Difficulty

In a recent installation which came to the writer's attention, the clutch shifting levers failed repeatedly, although they were apparently of ample strength. The clutches in question were of the spiral jaw type, as illustrated in Fig. 1, and the shifter lever was held in or out of engagement by a latch engaging a quadrant. More careful observation of the operating conditions showed the trouble to be as follows: When the speed of the driver was checked, either by overload of the adjacent machines, by two or more machines being thrown in simultaneously, or by cutting off the source of the power too quickly, the driven member *B* moved faster than the driving member *A*, owing to inertia. The clutches thus parted and caused the shifting lever to be broken. These clutches were replaced by the square jaw type, as shown in Fig. 2, and the trouble was thus eliminated.

Philadelphia, Pa. JOHN S. MYERS

A NOVEL SUGGESTION SYSTEM

It will be found profitable for any factory to adopt the plan of encouraging workmen to express their ideas on methods of improving operating conditions. Many managers recognize the benefits to be derived from such a plan, but find their time so completely occupied that they cannot give this department the necessary amount of attention.

The writer's idea of the proper method of conducting a "suggestion box" differs somewhat from that outlined by Mr. F. W. Harris in the April issue of MACHINERY, engineering edition. Our factory had better success than Mr. Harris appears to have had, although we also encountered a little trouble in certain directions. Our method of conducting the suggestion box differs somewhat from that which is customarily used and shop men will probably be interested in reading the following description. A list of prizes, ranging from $5 to $25, the total amount being $100, was offered for valuable suggestions, and any employe of the factory was eligible to compete for these prizes, no restriction being placed upon the nature of the suggestion. The "contest," as it was known, was open for a period of three months, at the end of which time a committee was appointed by the men who had offered suggestions to award the prizes. None of the contestants were eligible to serve on this committee. The benefit derived from such a plan lies in securing the cooperation of the men, in addition to the actual value of the ideas which they offered, although in many cases, the ideas were really of very considerable value.

Suggestion boxes were installed in the factory several years ago, but only one or two suggestions would be received each month. The contest revived interest in the plant to such an extent that there were nearly three hundred suggestions handed in to compete for the prizes. Some of these were neatly prepared and others were in the form of rough sketches on dirty pieces of paper. Nevertheless, the ideas were prepared with sufficient care to make them readily understood in most cases. As previously mentioned, trouble was encountered in certain directions, but it was never great enough to overbalance the benefit which was derived. At the present time, another contest has been started and seems to be arousing quite as much interest as the first one did.

Springfield, Ohio HAROLD G. SMITH

ANALYZING STRENGTH OF CYLINDER HEAD BOLTS

Many young mechanics are puzzled by the fact that the bolts which hold a cylinder head in place are not broken by the pressure in the cylinder, when the bolts themselves are tightened up to practically the point at which rupture occurs. For example, suppose there are six bolts holding the head on the cylinder which is shown in Fig. 1, and each bolt is

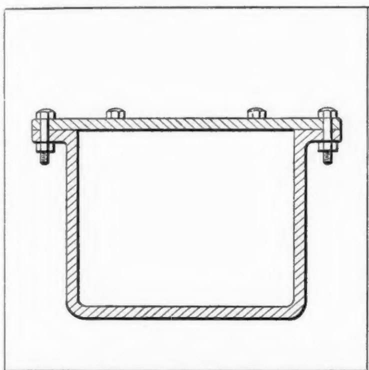


Fig. 1. Section through Cylinder

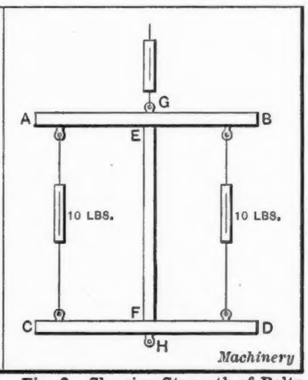


Fig. 2. Showing Strength of Bolts

tightened up nearly to its ultimate strength. Assuming the strength of each bolt to be 20,000 pounds, this would mean that a total pressure of about 120,000 pounds is applied to the cylinder head by the bolts.

When the steam is admitted to the cylinder, pressure is applied to the cylinder head from the inside, and it would seem as though the bolts would have very little strength to withstand this seemingly additional strain. The diagram Fig. 2 shows the reason why the bolts do not break. In this diagram, we will consider the rod *AB* to represent the cylinder head and the rod *CD* to represent the opposite end of the cylinder. The transverse piece *EF* is placed between these two rods and secured by means of two 25-pound spring-balances attached in the manner shown in the illustration. These balances are adjusted to indicate a tension of 10 pounds each and this corresponds with the stress in the cylinder head bolts. Now if a third spring-balance *G* is secured in the position indicated in the diagram, and the lower rod is fastened at *H* to some rigid support, it will be found that any pull of less than 20 pounds, which is registered by the balance *G*, will not be indicated by the two spring-balances which hold the rods *AB* and *CD* in place. The same conditions exist in the case of cylinder head bolts, it being necessary to apply a pressure which exceeds the total tension of the bolts before this pressure is effective in causing them to break.

Lynn, Mass. J. P. FARNSWORTH

AN INTERNAL CHUCK OF WIDE RANGE

It was necessary to hold the cylindrical steel casting, shown in Fig. 1, by the internal surface while the outside surface was being roughed off. A common mandrel or expanding ring chuck, although able to hold the work, did not have sufficient range to make up for errors in the castings resulting from poor molding. It was decided that an internal chuck was best for this operation and the design shown in Fig. 2 was developed, which not only meets all requirements, both in scope and strength, but is quite inexpensive as well. It consists of a casting *A* which, acting as a faceplate, is fitted to the lathe. The core of the chucking mechanism *B*, which

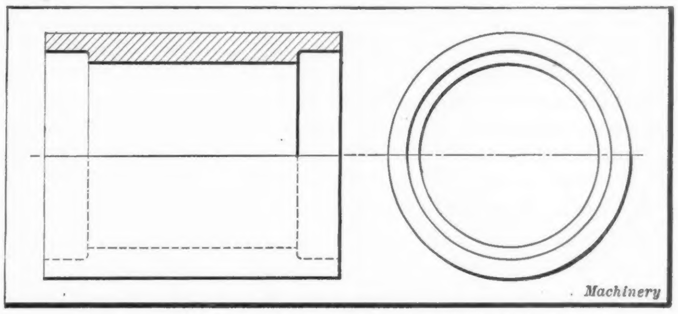


Fig. 1. Work that required Special Internal Chuck to hold it

consists of a tapered flange *Z*, and a projecting stud *Y* are turned out of one piece of tool steel and fastened to this faceplate. Segments *C*, *D*, and *E* are assembled to engage in the grooves *X* in the core. These segments were made from a ring turned to the same angle as that of the core *B*. The surfaces of the pads *W* which engage with the work are checked like the jaws of a chuck to give them a firm grip. The tapered collar *F*, which also has a groove that engages the extension on the segments to prevent them from falling out, is assembled over the stud. The washer *G* is now placed on the stud and when the nut *H* is screwed up, the chuck is made a unit which will expand or contract as desired. It will be noted that each segment has two pins projecting from its lower surface which engage a keyway *V*. These pins are used to prevent the segments from falling together. Although it is not absolutely necessary, a flat spring may now be sprung over the three segments as shown at *J*; this spring will tend to contract the segments readily when the nut is loosened, and also prevent

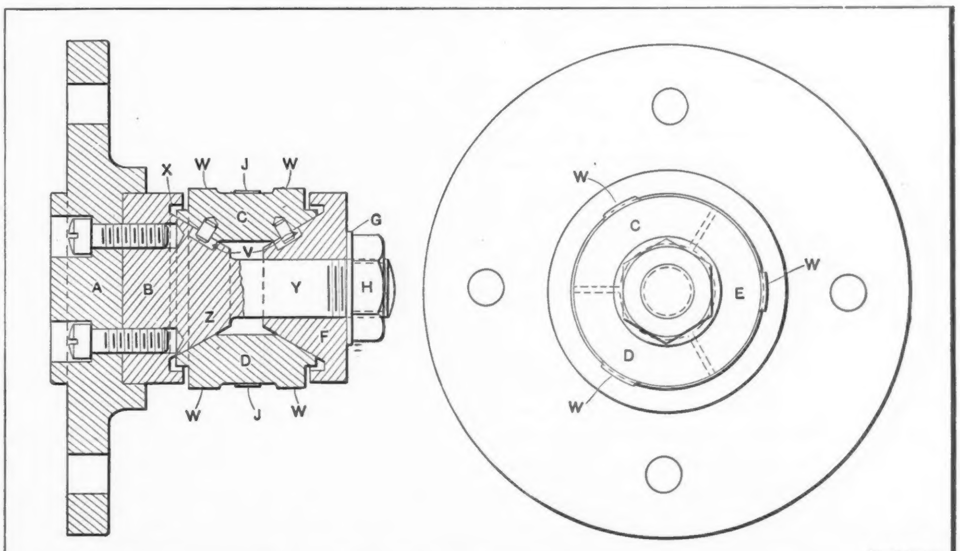


Fig. 2. Internal Chuck having a Range of 1/4 Inch

them from falling off if the nut is unscrewed too far.

A chuck of this design has a range of nearly 1/4 inch and the question of the strength of its grip is a mere matter of leverage. It must be remembered that if two turns of the nut of a mandrel will expand the ring 1/32 inch, while the same number of turns will expand this chuck 3/16 inch, the difference will have to be compensated for by an increased leverage at the wrench. That is the reason that a hardened tool-steel stud and nut is absolutely necessary because a

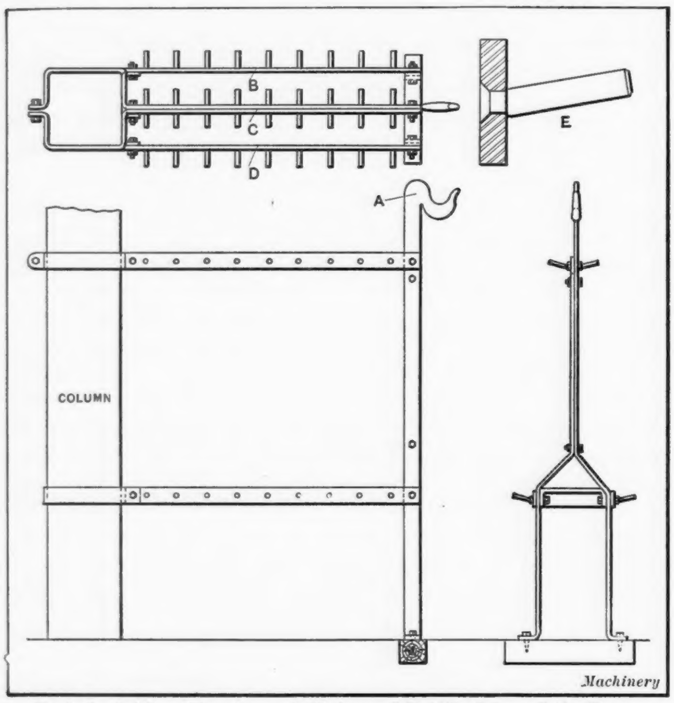
wrench 20 to 24 inches long must be used. A chuck constructed along these lines needs not even the aid of a driver to withstand the thrust of an extra heavy steel chip. It is compact, efficient, inexpensive, and last but not least, it will stand up.

R. Franz Elhop

RACK FOR HOLDING WRENCHES AND CHAINS

The illustration shows a convenient form of rack for holding wrenches and chains. The importance of keeping the different forms of wrenches and chains that are required in a shop in some handy place so that each workman knows where to locate them is obvious. If the tools are left scattered around the shop, a great deal of time is lost in looking for the particular size that is wanted. The use of this rack has done away with the loss of time resulting from this cause, and by so doing has been the means of effecting a material reduction in operating costs.

Referring to the illustration, it will be seen that this rack is attached at one end to a column, the other being held by the support *A* which has a hook at its upper end from which



Rack for holding Wrenches and Chains and Detail of One of the Pegs

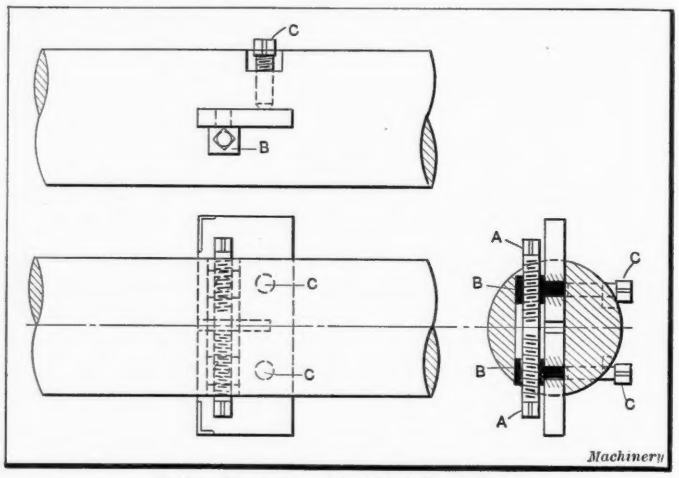
the chains are suspended. *B*, *C* and *D* are the three parts from which the wrenches are suspended. Holes are drilled in the handles of the wrenches about 1/16 inch larger in diameter than the pins in the rack. The size of rack will, of course, be made suitable for the purpose for which it is intended. A detail of one of the pins and the method of mounting it in the rack is shown at *E*. The design could easily be modified by having a support *A* at each end of the rack. In this case, the rack could be set in any convenient position on the floor of the shop and a hook for carrying chains could be provided at both ends.

Lincoln, Neb. H. E. Gillette

ADJUSTABLE BORING BAR

The cutters of an ordinary boring bar soon become dull when the tool is working constantly on steel, hard brass or similar stock, and it is an expensive matter to replace them. The tool illustrated herewith is provided with an ingenious method of adjusting the cutters so that it is possible to compensate for wear. Referring to the illustration it will be seen that the cutter is split through the center and the two halves are adjusted by the screw *A* which is threaded right- and left-hand. The two threaded sections of this screw run in the tapped holes in the dogs *B* which fit into suitable holes in the cutters. After the required adjustment has been secured the cutters are clamped firmly in place by means of the screws *C*.

In using this tool it is an easy matter to compensate for any wear which develops in the cutters, as it is merely necessary to loosen the screws *C* and then turn the screw *A* sufficiently to obtain the required distance between the cutting edges. Consequently, there is no necessity for variations in the work to be produced through wear in the boring bar. It will be evident that a number of different cutters could be made for use in a single bar, and for this purpose it would only be necessary to make the various sized cutters, having the holes in them of a



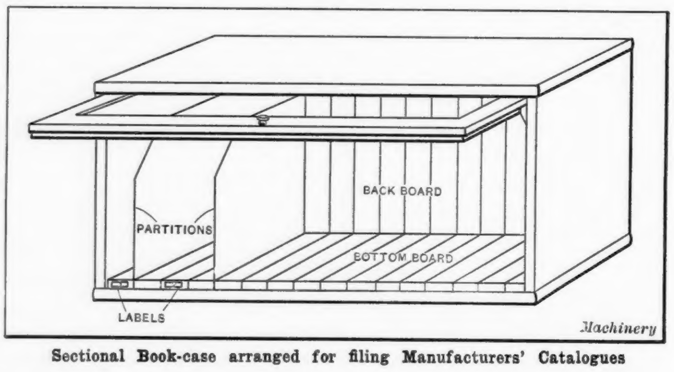
Boring Bar made with Adjustable Cutters

standard size so that the driving dogs *B* and screw *A* could be used for all sizes of cutters. When assembling a bar of this type, the dogs are screwed onto the adjusting screw to such a position that the two dogs can be entered into the corresponding holes in the cutters. The whole arrangement is then slipped into the bar and fastened by the two screws *C*. Experience has shown that the screw is most effective when placed quite close to the cutting edge of the cutter.

W. R. G.

FILING CATALOGUES

The writer has seen several letters in Machinery regarding the use and abuse of catalogues and believes that many readers will be interested in the method of filing catalogues which is used in the factory where he is employed. The accompanying illustration shows one section of a sectional book-case, which has been fitted up to receive catalogues. As additional sections can be added as required, this method makes it easy to provide more space whenever it is necessary.



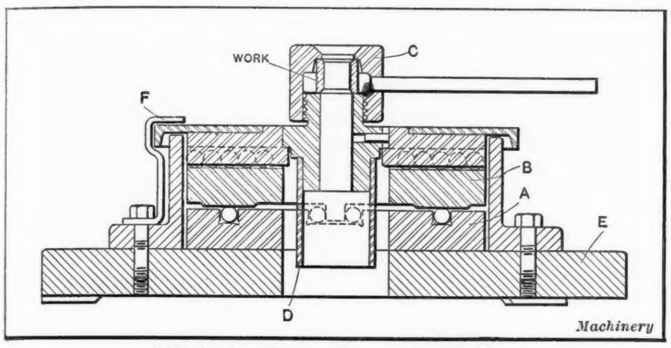
Sectional Book-case arranged for filing Manufacturers' Catalogues

Referring to the illustration it will be seen that saw cuts are made in the bottom and back boards of the book-case at intervals of 2 inches, and partitions are made of 24 gage galvanized iron to fit in these cuts. It will be obvious that the partitions can be fitted in any of the slots to provide spaces to suit the number of catalogues on different subjects. A card index is kept in connection with this cabinet, the catalogues being listed in this index under the manufacturers' names and also under the classes of equipment which are shown in them. It has been found that the ease with which any catalogue can be located by this means, has more than paid for the trouble that was taken in fitting up the cabinets and compiling the card index.

Lancaster, Pa. D. R. Long

SELF-ALIGNING REAMING FIXTURE

In describing the accompanying design for a self-aligning reaming fixture, the writer presents a very useful tool to the readers of MACHINERY. It is used for reaming small bushings or other parts which cannot be handled in a turret lathe. The bottom plate *A* has grooves cut in its upper surface which are filled with hardened steel balls. These balls bear on the sides and bottoms of the grooves with about 0.001 inch clearance on the sides. Plate *B* has a tongue which engages between two rows of balls in the center groove of plate *A*, this groove being provided to locate the fixture longitudinally. In the top of plate *B* there are grooves similar to those in plate *A* except that they are cut at right angles to those in plate *A*. These are also filled with balls which locate the fixture transversely.



Self-aligning Fixture for reaming Bushings

It will be evident from this description that as soon as the reamer touches the work, the fixture will adapt itself to the center of the reamer. The cap *C* has an internal thread which is relieved after the manner of a breech block for the purpose of rapid manipulation. Tube *D* is used as a spout to carry away the cutting fluid which is used on the work. Pads are provided on the under side of the plate *E* which raise the base enough to allow the cutting fluid to escape. The clamp *F* is simply used to hold the fixture so that the plates will not rise when removing the reamer from the work.

Bristol, Conn. F. A. HOTCHKISS

ANGLE AND TRANSFER GAGES FOR DIEMAKERS

The illustrations show two tools which the writer has found particularly useful during his experience as a diemaker. The tool shown in Fig. 1 is an angle gage which was especially designed to test the clearance on dies, but it will also be found useful on other classes of angular work. The tool is made from a Starrett adjustable square, the blade of the gage being the only part which has to be made especially for this tool. This blade is made of tool steel and is hardened, ground and lapped to an accurate finish; it has a knife edge *C* on the working side. The groove *D* is made to slip over the extension *E* on the hook-bolt of the adjustable square. In using the gage, the blade is set to the required angle by using a protractor on the edge *H* of the tool body and the edge *I* of the blade; the nut *F* is then tightened so that the hook-bolt draws the blade up against the end of the slot *G*, clamping it securely in position. As the knife edge *C* has been made exactly parallel with the edge *I*, this method of setting the gage is quite accurate. The blade can be set at any desired angle so that the gage is universal in its application.

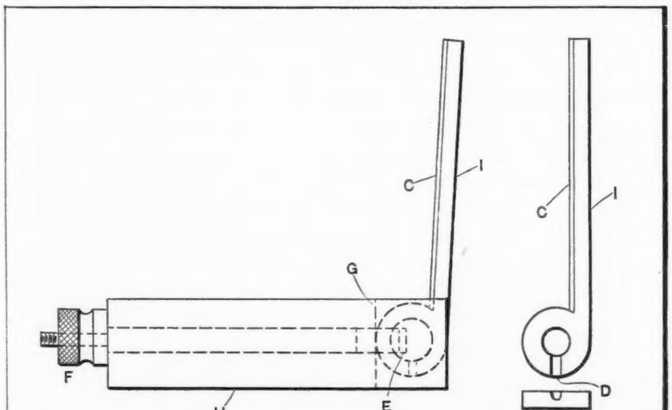


Fig. 1. Angle Gage for securing Required Clearance on a Die

The tool shown in Fig. 2 is a transfer gage for use in locating the holes in a punch-pad so that they will be in exact alignment with the corresponding holes in the die. The hole *A* in the gage is 0.250 inch in diameter and is exactly square with the base of the tool body, which is hardened, ground and lapped to an accurate finish. In using the tool, a temporary punch *B* is made to fit accurately in the hole *A*. After the hole for the first punch has been drilled in the punch-pad and the punch *D* set up in it, the punch *B* is inserted in the tool and placed in approximately the desired position on the punch-pad. The screw *C* fits into the hole which screws the punch-pad onto the extension holder. The die is then placed over the punch so that the punch *D* enters the corresponding hole in the die, after which punch *B* is moved around until it fits into its corresponding hole in the die. The screw *C* is next tightened up so that the transfer gage is held securely in position on the punch-pad. The die is then lifted off and the punch *B* removed from the transfer gage. The hole in the punch-pad to receive the punch is now drilled and reamed through the hole *A* in the gage, which serves as a guide for this purpose. The writer has found this to be the most rapid and accurate method for performing this operation which has ever come to his attention.

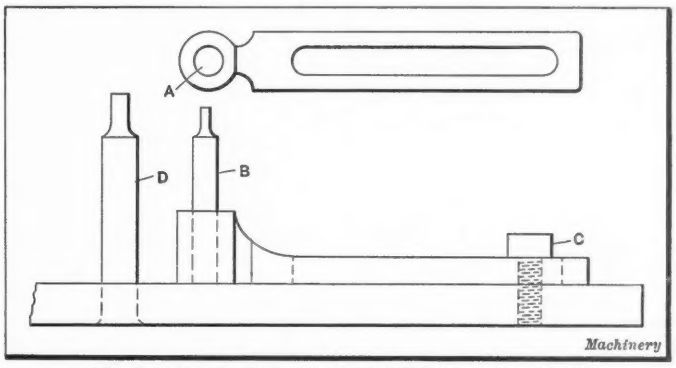


Fig. 2. Transfer Gage for locating Holes in a Punch-pad

Detroit, Mich. A. TIMMS

TOOL FOR FORMING HARD RUBBER

We unconsciously adhere to precedent or move in a rut, so to speak, and it often happens that a mistake or an accident rather than sound reasoning proves the means of throwing light on a perplexing subject. After the accident, with its accompanying enlightenment, we find that we have the means at hand for satisfactorily producing the quantity or quality for which we have been striving. But it makes us feel rather foolish to find that the solution was reached by a path directly opposite to the one we were following.

Of several instances that have come to my notice, I recall one in particular. I was employed as a toolmaker and it fell to my lot to make a circular forming tool for forming pieces from hard rubber rod. We used carbon steel almost exclusively in those days and as the forming tools would not "stand up" to cut many rubber pieces, the boss obtained a sample of special steel that would harden at a low temperature and in oil. He said, "When you come to harden that tool, heat it to a bright red and dip it in water; that ought to make it hard enough." I chucked the disk of steel he gave me, and when facing it off, I noticed that it did not "feel right" when the lathe tool was cutting. I went to the boss and told him that I did not like the way that new steel cut, as the chip rolled off as smooth as machine steel and it did not feel gritty enough for tool steel. He replied that it was a well annealed and especially fine grained tool steel. I completed the tool and decided that if that steel would harden at a dull red in oil, it would be very likely to fly into a thousand pieces if heated to a bright red and dipped in water; and concluded that the "old man" had better do the hardening himself. A wire was placed through the hole and just as the boss removed the tool from the bath, the foreman of the

screw machine department happened to pass. The boss told him to take the new tool and see how it would "stand up" in one of the machines. After flashing the tool over the fire once or twice to remove strains, he handed it over to the foreman who tried out the tool.

Several hours later I visited the screw machine department and asked the foreman how the new tool was "standing up." "Fine," he answered, "we made over 300 pieces before we had to sharpen it." I strolled over to the machine to watch it work and noticed that the face of the tool had several small dents in it where the machine setter had probably tapped it with a wrench while setting the cutting edge on center. That piece of special steel was cut from the wrong bar and the forming tool that was giving such good results was made of machinery steel. We concluded that the reason why the soft steel tool stood up longer than a very hard tool was due to its ability to become charged with the gritty substance in the rubber that is so disastrous to the keen edge of a hardened tool. Had we not made this mistake, probably our next move would have been to use high-speed steel.

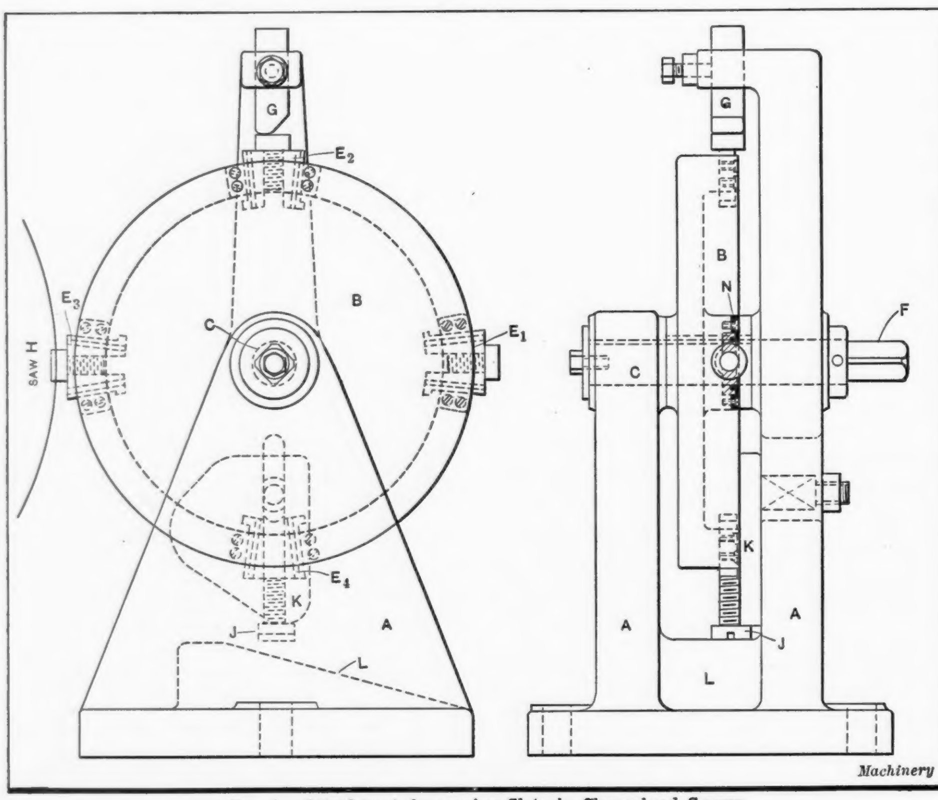


Fig. 1. Attachment for sawing Slots in Cheese-head Screws

It rather upsets precedent to state that, for this class of work, cast brass will stand up longer than very hard steel. Several times in later years, when making tools for working compound, fiber or hard rubber, I have used machine steel, and after grinding them to a keen cutting edge, I have rolled fine emery into the face of the tools. Diamond dust is better. With the face of the tool charged with a substance harder than the grit in the work, it prevents the hard rubber acting as a very fine emery wheel and grinding away the edge.

Pittsfield, Mass. F. E. Shailor

SCREW SLOTTING FIXTURE

The illustrations show a fixture used for cutting the slot in cheese-head screws when large quantities are needed. Referring to Fig. 1 it will be seen that this fixture consists of a stand A which carries the circular disk B mounted on shaft C. This disk is equipped with four holders E_1, E_2, E_3 and E_4 which carry the screws that are to be slotted. When it is desired to use this fixture, the workman places a handle on the square end F of shaft C; he then places a screw to be slotted in the holder E_1 and turns the handle. This turns the disk and the screw reaches position E_2, where it is pressed down between the taper wedges of the holder by the adjustable dog G on the top part of the stand A. The saw H is set to cut a slot of the required depth as the screw passes over it at E_3; the workman keeps on turning the handle and the disk moves on until it reaches position E_4, where the edge of the screw head shown at J is gripped by the adjustable plate K and withdrawn from its holder. The illustration shows a screw just leaving the holder, from which it falls onto the inclined surface L and slides down into a tray. When a number of screws are wanted, the workman keeps on turning the handle with his right hand and places a screw in each holder as it comes around; the cutting of the slots in the screws is almost continuous, one slot being cut for every quarter of a revolution of the disk.

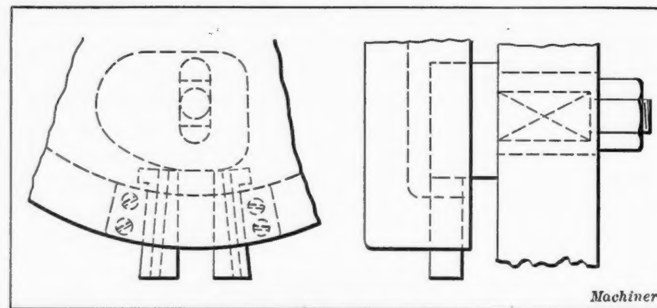


Fig. 4. Special Clamping Mechanism which ejects through Engagement of the Wedges with a Dog

Fig. 2 shows an enlarged view of one of the holders. When the workman presses a screw into the holder, the head S pushes the two wedges M down the tapered hole cut in the disk, forcing them together to secure a grip on the screw that is to be slotted. The plates N act as guides and supports for these gripping members, and the projections O on the ends of wedges M prevent them from coming out when the screw is forced from the holder after the slot has been cut. This tapered holder is adapted for different sizes of screws by moving the wedges in or out. When the screw is withdrawn, the wedges are opened up a little and this makes it easier for the workman to insert an unslotted screw in its place. If just placed in the holder, the screw will be forced in when it reaches the dog G. Screws can be slotted very rapidly by this method, as the pause which occurs when cutting the slot gives the workman time to insert another screw in the holder at E_1.

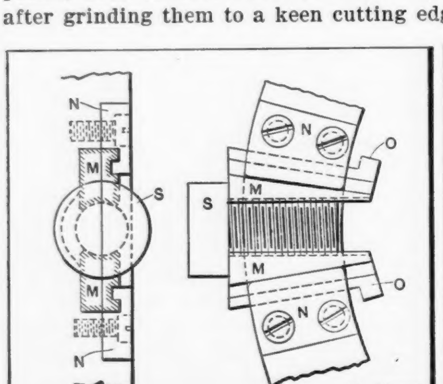


Fig. 2. Enlarged View of Jaws of the Clamping Mechanism shown in Fig. 1

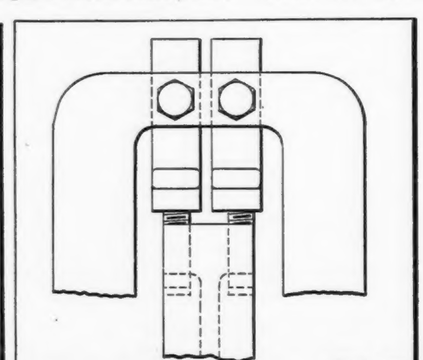


Fig. 3. Multiple Fixture arranged for using Two Saws

Fig. 4 shows another arrangement for withdrawing the screw. Instead of the plate forcing the screw itself out, the jaws of the holder are forced back along the tapered hole, thus opening them and allowing the screw to drop out. This method is

especially suitable for use with headless screws. The first method is, perhaps, the best, as having the screw itself pulled out does away with any chance of its sticking. If required, more than four holders could be arranged around the disk, but it is doubtful whether this would be worth while, for it would only mean a shorter movement to bring the next screw to the saw and this can be done very quickly with four holders.

Fig. 3 shows a double fixture that can be used when two saws are available to cut the slots; these saws are placed side by side, the distance between them being the same as between the two sets of holders. There would, of course, be two sets of stops and withdrawing attachments used with such a fixture, and this idea might also be carried still further by having several rows of screws going at once. By this means, different diameters and different lengths of screws could be slotted at the same time. The holders could, if necessary, be set at unequal distances around the disk, so that the different operations of cutting the slot, withdrawing, or putting the screw in place, would be done at different times, thus requiring the workmen to apply less force to turn the handle.

Manchester, England W. R. OAKES

A SIMPLE TOOLPOST GRINDER

The design for a toolpost grinder presented in this article is not advanced as an example of the highest class of tool making, but simply as a useful grinding attachment for the lathe. It was made to meet the requirements of a special class of work and gave entirely satisfactory results. The construction is extremely simple and will be readily understood by referring to the accompanying illustrations.

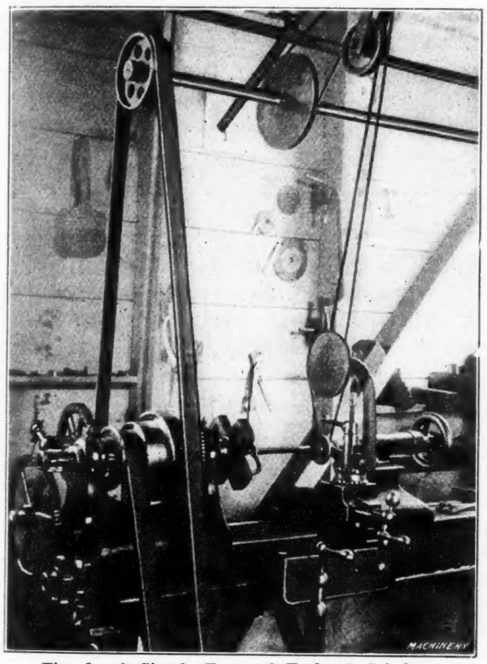


Fig. 1. A Simple Form of Toolpost Grinder

The wheel is carried on a stud, as shown, mounted in the shank that fits in the toolpost, and is driven by a small pulley belted to the speed pulleys which provide for a surface speed of 5000 feet per minute on a 2-inch wheel. The stud on which the wheel runs is made of ¼-inch drill rod and the sleeve which carries the wheel is of gun-metal. These two parts were

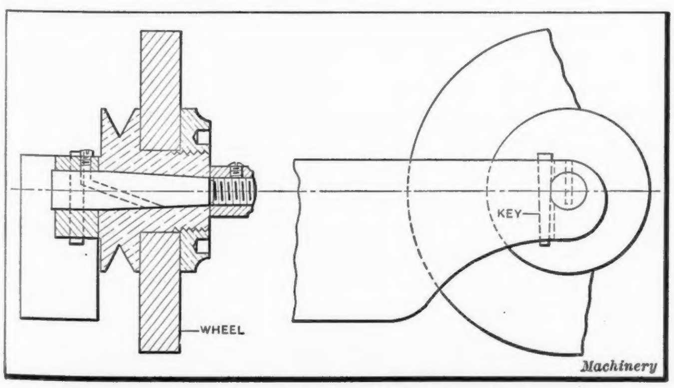


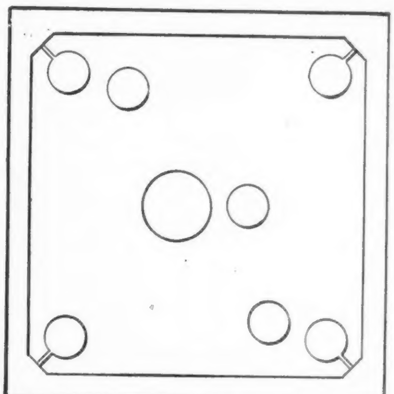
Fig. 2. Design of the Wheel Support for the Toolpost Grinder

ground together after the stud was hardened, in the same way that the plug and barrel of a water tap are ground, oilstone powder being used as an abrasive. It will be seen that a small steel wedge holds the stud in position in the shank, and adjustment is made by tapping the stud backward or forward and then clamping it in the required position. The speed pulleys are made of wood bushed with gun-metal.

Christchurch, New Zealand. JOHN PEDDIE

METHOD OF PREVENTING DIES FROM CRACKING THROUGH SCREW-HOLES

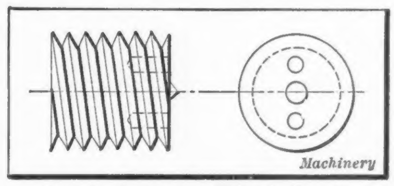
The writer has found that many dies are lost by cracking through screw or dowel pin holes. This is particularly true if these holes are located at the corners of square or rectangular die-blocks. The following gives a simple method of eliminating this difficulty which has given very satisfactory results. The corners of the die-block are cut away in a shaper or milling machine, as shown in the accompanying illustration. After this operation has been performed, a slot is cut into the screw hole with a very fine saw. This gives the block a little play, and relieves the strains set up in the metal in hardening, thus preventing the die from cracking.


Method of preventing Dies from cracking at Screw or Pin Holes

New York City THOMAS WILLIAMS

CENTERING PLUG FOR LAYING OUT DRILLED HOLES

The following is a simple and effective method of laying out holes in bronze wearing-plates for locomotive driving wheels where the holes have not been uniformly spaced. It was formerly the practice to use the old plate for locating the holes when it was necessary to replace the wearing-plate in a wheel. This method was unsatisfactory because the holes in the old plate were more or less worn, so that inaccuracy in the location of the holes resulted. These bronze wearing-plates are located on the inside face of the wheel-hub, the hub being counterbored to a depth of ⅜ inch to receive the wearing-plate, and eight ⅞-inch holes are drilled and tapped in the hub to a depth of 1½ inch to secure the wearing-plate in place.



Plug for laying out Holes in Bronze Wearing-plates

To provide for doing this work rapidly and accurately, the writer devised the following method of procedure: Eight plugs of the design shown in the accompanying illustration, ⅞ inch in diameter by ⅞ inch long were turned, threaded and drilled with two ⅛-inch holes ⅜ inch deep. These holes are for the purpose of enabling the plugs to be screwed in with a spanner. The plugs are screwed into the wheel hub so that they are flush with the surface, leaving the small points projecting. A manilla paper washer is next cut to the size of the counterbored hole and slit on one side to enable it to be slipped over the axle. This paper washer is then inserted in the counterbore and a light pressure of the thumb on the plugs causes the projecting points to pierce the paper. In this way, a templet is produced which accurately locates the centers for drilling the holes in a new wearing-plate. Seven-eighth inch screws are used for attaching all sizes of wearing-plates to the driving wheels so that the same set of plugs can be used for laying out the plates for different sized wheels. This method affords a rapid and accurate means of doing this work, and after drilling and countersinking the wearing-plates, they can be fastened to the wheels without any trouble.

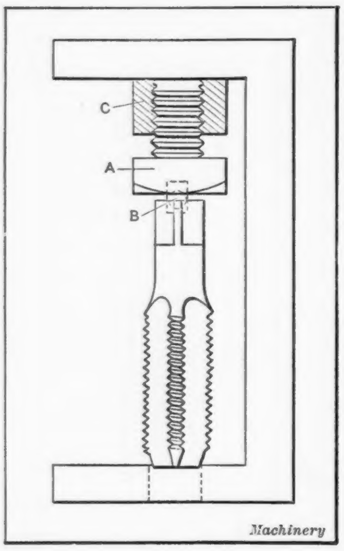
Catasauqua, Pa. EDWIN CHAPMAN

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

STEEL BALL FOR HOLDING TAPS AND REAMERS

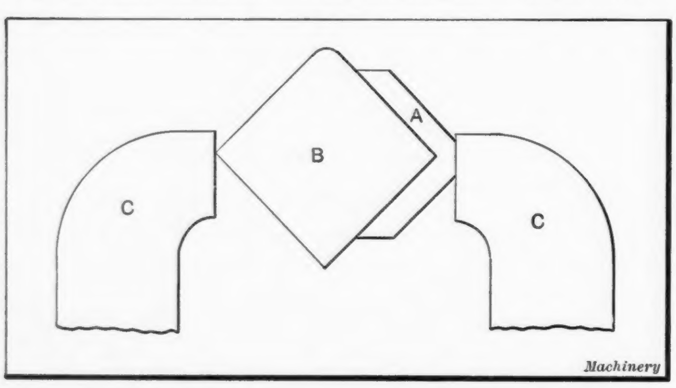
The accompanying illustration shows a convenient method of holding taps, reamers, etc., in close quarters. Referring to the illustration, it will be seen that a hole is drilled in the end of the tap shank and a corresponding hole drilled in the head of the bolt *A*. The depth of the holes is a little less than half the diameter of the ball *B*. In tapping a hole with this apparatus, the bolt is screwed all the way into the block *C*. The tap is next placed in position and the ball *B* placed in the hole in the end of its shank. The bolt *A* is then screwed out, so that it comes into contact with the ball *B*. It will be seen that under these conditions the ball prevents the tap from dropping out of place. The tap can then be driven in the usual way, the bolt *A* being unscrewed at about the same rate that the tap is screwed into the work.



Corbin, Ky. J. A. Jesson

HOLDING SQUARE PIECES CORNER-WISE IN A VISE

When it is required to hold square pieces corner-wise in a vise in order to round off the corners, or for any similar operation, the attachment *A* shown in the accompanying illustration will be found convenient. This attachment is made from a

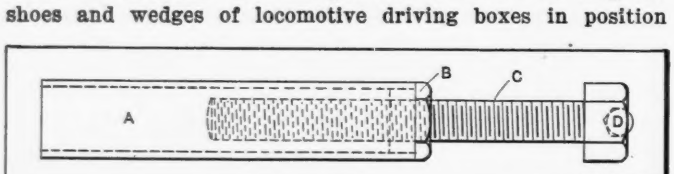


piece of ½ by 1 inch flat bar, machined to the shape shown in the illustration. It will be seen that the work *B* fits into the angle in the attachment while a sufficient flat is provided on the opposite side to give the vise jaw *C* a good bearing surface.

Dubuque, Iowa. E. J. Buchet

SPREADER FOR SHOES AND WEDGES

The illustration presented in connection with this article shows a convenient form of spreader for use in holding the shoes and wedges of locomotive driving boxes in position

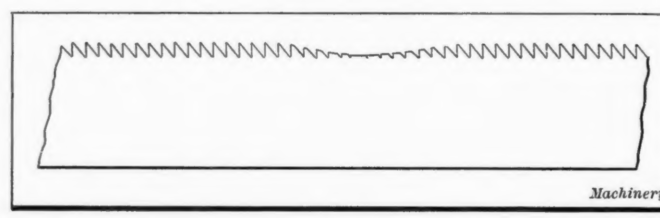


while adjusting their alignment. It is constructed of a piece of 1¼-inch wrought iron pipe *A* which has part of a ⅞-inch hexagonal nut *B* forced into it. The top part of this nut is left in its original shape so that it forms a shoulder, which prevents the nut from slipping into the pipe when the pressure is applied. The screw *C* is an ordinary machine bolt ⅞ inch by 8 inches in size, in which a steel ball *D* ½ inch in diameter has been inserted. The edges of the head of the bolt are peened over around the ball to prevent it from dropping out. This ball constitutes the bearing point for one end of the spreader and prevents the bolt head from coming in contact with the shoe while it is being turned in tightening up the shoe and wedge.

Olean, N. Y. Leroy Smith

TO INCREASE THE LIFE OF A HACKSAW

Many mechanics have doubtless noticed that when one tooth of a hacksaw blade is broken out, the teeth next to it will soon break, and that the blade will not last long after one tooth has failed. This condition is particularly noticeable when sawing rather thin sheet metal or starting on the corner of a heavier piece of work; the latter cause of breaking blades might easily be avoided by setting the work up so that the saw will not start to work on the corner. When one or two teeth on a saw blade are broken, the writer has found

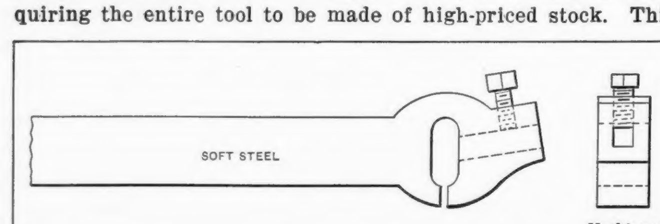


it to be a good plan to grind down the adjacent teeth on each side of the gap, graduating them in the manner shown in the illustration. This does away with the sudden jerk which occurs when the gap caused by a broken tooth allows the saw to drop down over a sharp corner or the edge of a thin piece of work; hence, the tendency to "dig in" or "bite" is eliminated, together with the tendency for the uneven action to break the blade.

Meriden, Conn. James Gallimore

LATHE SPRING TOOL

The accompanying illustration shows an improved form of lathe spring tool intended to take the place of the type of goose-neck spring tools which are in common use. The advantage of the present design lies in the fact that it is adapted for holding cutters of ordinary square tool steel, instead of requiring the entire tool to be made of high-priced stock. This



tool gives excellent results in cutting worms in a lathe and can also be used in a variety of other classes of service. Little explanation is necessary to make the advantages of this tool evident to any mechanic, and dimensions have been omitted because it will, of course, be necessary to make the tool of a suitable size for the class of work on which it is to be used.

Denver, Colo. Stanley Edwards

MAKING MALE AND FEMALE TEMPLETS

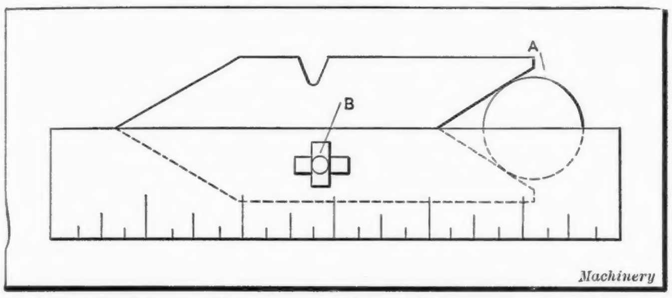
The writer has noticed toolmakers and diemakers holding small male and female templets up to the light in fitting them together. Where this method is used, it is difficult to hold the faces of the two templets exactly square, and unless this is done errors are likely to be introduced. An easy method of

avoiding this difficulty is to place the two templets against a piece of glass. In this way, they are held square with each other and can be fitted together by the method previously referred to.

Newark, N. J. EUGENE LEACH

CENTER GAGE AND INCH SCALE USED AS CENTER SQUARE

A center gage and a 4-inch scale may be combined for use as a center square. This is done by placing the scale on the center gage so that one edge of the scale coincides with the center line of the center gage and projects beyond the end *A*, as shown in the illustration. The use of this combination as a center square may be briefly described as follows: To center the end of a piece of round stock, place the end of the stock in the end *A* of the center gage under the



scale, and draw a line across the stock, using the edge of the scale as a straightedge. Then turn the stock through one-fourth revolution and draw another line as before. The intersection of these two lines determines the center of the end of the stock.

A T-head bolt *B* can be securely fastened to the center gage in a crosswise manner, as shown, and the scale slotted lengthwise to correspond. This enables the mechanic to use the scale and center gage either separately or in combination.

Boston, Mass. ADELBERT PEON

ERASING INK MARKS FROM TRACINGS

The tool illustrated herewith is intended for erasing ink marks from tracings. It is made from a piece of a hacksaw blade on which the edge *A* is ground down as shown in the illustration. This is a much more satisfactory tool than a knife for taking the preliminary steps in removing ink marks. The flexibility of the hacksaw blade enables it to be bent down so that it lies almost flat on the paper, and in this way the ink can be removed without cutting the cloth. The sharp corners of the blade can also be used for removing dots, fine

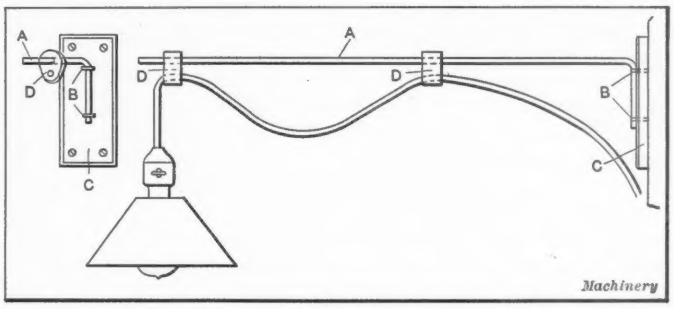
lines, or lines close together. After the bulk of the ink has been removed, an ink eraser is used to remove most of what is still left. The tracing is then cleaned with a pencil eraser, after which it is burnished with the rounded section of the blade shown at *B*. The end *C* may be conveniently used as a tack-puller. This may seem a complicated way of making an erasure, but the writer has found it to be an extremely convenient method and one which gives very satisfactory results.

Brazil, Ind. LEROY M. CURRY

ELECTRIC LIGHT BRACKET

In some sections of the country the need for artificial lighting in shops and factories is confined to the two or three winter months, and then only for a few hours at each end of the day. Where such is the case it is hardly worth while to install expensive equipment for lighting purposes, when a simple homemade apparatus can be designed to meet all the requirements.

The accompanying illustration shows the equipment used in a plant engaged in the manufacture of a mechanical device, and can be explained as follows: The swinging arm *A* is held to the window casing by the holders *B* attached to the

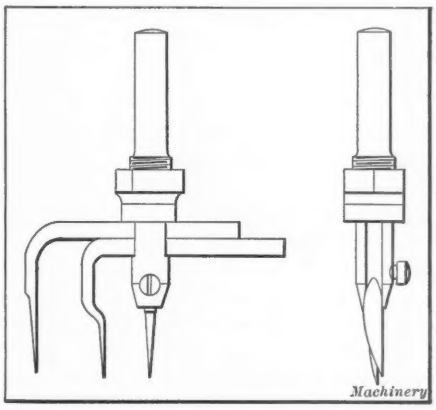


block *C*. The position of the lamp is controlled by the cord passing through the holes in the maple blocks *D*, whereby the height of the lamp is arranged to suit the convenience of the operator. In use, this method has been found economical and efficient. The bracket is quickly adjusted and is giving very satisfactory results.

Hartford, Conn. CHARLES F. SCRIBNER

CUTTING RUBBER DISKS

It often happens that a shop has more or less call for rubber, fiber or leather disks and washers. The quantity needed is usually small and would be rather expensive to purchase. The illustration shows a handy device for cutting such disks and washers cheaply and, what is quite important, exactly, to any required diameter. This tool is provided with a shank adapted to fit into the ordinary drill-press chuck, and the cutting arms are adjustable to different diameters by the use of the hexagon lock-nut and washer shown in the illustration. The piece of sheet rubber, fiber or leather is laid upon the drill-press table, and the rapidly revolving tool is forced down into the material exactly as in ordinary drilling operations. If the center hole left by the guide-pin is objectionable, or if only a disk is wanted, the pin and inner cutting arm may both be removed, but the piece of material which is being worked on must be held firmly upon the drill-table. In all cases, a piece of soft wood should be put under the material; this will prevent dulling the points of the cutting knives against the iron table. In cutting rubber, a little water should be used as a lubricant.



A CONNECTICUT MANUFACTURER

* * *

In a report made under the direction of the Associated Factory Mutual Fire Insurance Companies, the value of sawdust for extinguishing fires in japanning tanks and similar classes of factory equipment is described. Sawdust would hardly be regarded as a suitable medium for this purpose but experiments conducted by Mr. E. A. Barrier of Boston, have shown that it is more efficient in dealing with small outbreaks of fire in liquid combustibles such as lacquer and oil, than sand—the material which is most generally used. For this purpose it appears to make little difference whether the sawdust is wet or dry, but the mixture of bicarbonate of soda with the sawdust adds materially to its efficiency. This is due to the decomposition of the bicarbonate of soda with the consequent liberation of carbon dioxide. The greater efficiency of sawdust than sand for extinguishing this kind of fire seems to be due to the fact that the sawdust remains on top of the burning material for a greater length of time than sand, owing to its being less dense.

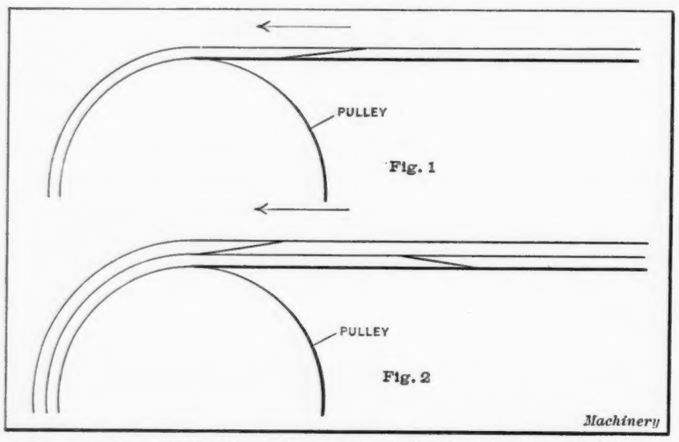
HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

INCLINATION OF BELT LAP-JOINT

H. B.—In what direction should the lap-joint of a belt incline, relative to the direction of the belt's motion? Should the leading end or point of the lap be next to the pulley or on the outside?

A.—There is a difference of opinion among mechanics and belt makers regarding this point. The Chicago Belting Co. recommends the method shown by the accompanying illustrations, which we believe is also advocated by most belt manufacturers. Fig. 1 shows a single-ply belt and, as will be seen, the leading end of the lap is on the pulley side. The lap is inclined in this way to prevent the end from opening. When the leading end is on the outside, it tends to open up slightly, especially if the belt is operated at high speed, owing to the resistance of the air. As soon as there is a very slight opening, the atmospheric resistance tends to increase it, but when the leading end of the lap is next to the pulley, any



Figs. 1 and 2. Inclination of Lap-joint relative to Direction of Motion for Single and Double Belts

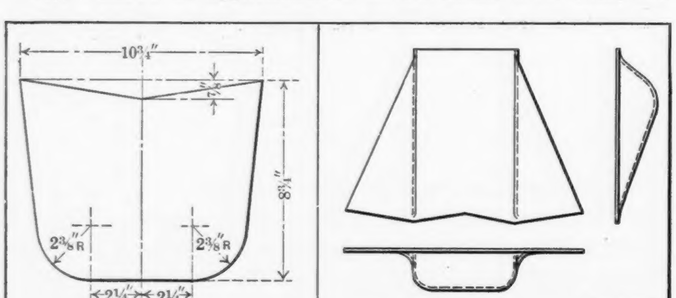
tendency of the point to rise, is overcome by frequent contact with the pulleys. Fig. 2 shows how the lap joints of a double or two-ply belt should be inclined. In this case, the lap of the outer ply is in the same relation to the direction of motion, as for a single belt, whereas, the lap of the inner ply inclines in the opposite direction. With this arrangement, the leading ends of the laps in both plys, will be inside and protected, and the outer ends are to the rear and not subjected to the atmospheric resistance.

A PROBLEM IN PRESS WORK

Answered by J. Stanitz, Buffalo, N. Y.

The following will answer the question asked by "P. B." in the May issue of MACHINERY in regard to a method of producing dies for drawing a steel shell of the form illustrated.

Fig. 1 shows an approximation of the blank to be used, the



Figs. 1 and 2. Approximation of the Blank and the Work after the First Drawing Operation

exact shape being found by repeated trials. Successive blanks are cut out by hand, being slightly modified until a shape is finally produced that will have the form shown in Fig. 2 after the first drawing operation. The curved notch in the front of the shell is not cut in the blank, but trimmed out after the shell has been completely drawn up. Fig. 3 shows the punch and die used for the first drawing operation, which are made of cast steel. This punch and die are used in a double-action drawing press. If difficulty is experienced through the shell breaking at the deep corner, the blanks should be annealed before drawing. The "hold-down" which keeps the blank in firm contact with the die should be adjusted so that the metal will be able to flow easily; at the same time the blank should

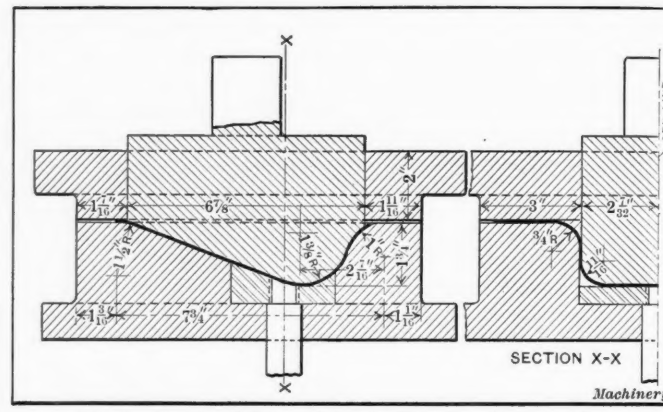


Fig. 3. Punch and Die used for the First Drawing Operation

be held tight enough to prevent wrinkles forming in the shell. The die is provided with a "kicker" which is operated by the positive knockout of the press. After the first trial has been made with this punch and die, the stamping will show where there is too much or too little metal and the shape of the blank must be modified until it gives satisfactory results.

The punch and die which are used for the three succeeding operations are shown in Fig. 4. Three punches are provided, all of which operate in the same die. The radii *A* on these punches are ½ inch, ¼ inch, and 1/16 inch, respectively. If a very sharp corner is required, another punch for use in a

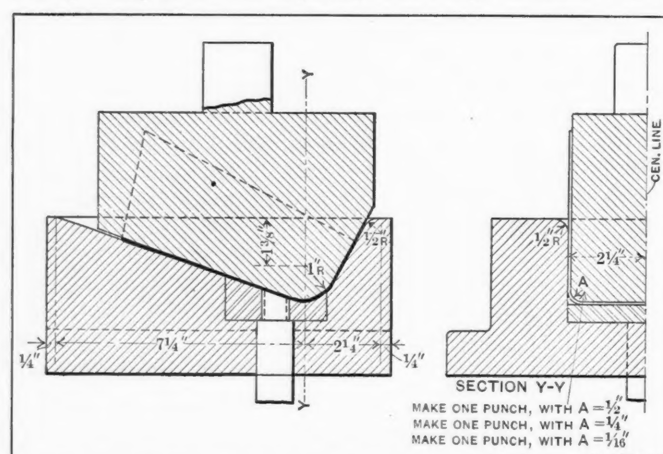


Fig. 4. Punches and Die used for the Second, Third and Fourth Drawing Operations

fifth drawing operation will probably be necessary. This punch and die is operated as follows: The shell, as it comes from the first drawing operation, is placed on top of the die; the punch then descends and reduces the radius of the corners from 11/16 inch to ½ inch and bends up the two "ears" which form the sides of the shell. After the corners have been reduced to the proper shape by the successive drawing operations, the curved notch in the front of the shell is trimmed to shape in a punch and die which needs no description to make its construction clear to any mechanic. In order to obtain satisfactory results, it is absolutely necessary to bring the shell to the shape shown in Fig. 2 in the first drawing.

* * *

During the International Exhibition at Ghent, Belgium, this summer, the Zeppelin firm will maintain a regular airship passenger service between Düsseldorf, Germany, and the exhibition grounds. The distance is about 130 miles. The service will be maintained throughout the months of August, September and October, and the fare for the flight will be $70.

SECTIONAL PUNCH AND DIE CONSTRUCTION

BY A. L. MONRAD*

The punch and die that are to be described in this article differ considerably from the usual type of sectional punch and die construction. It is always the desire of a tool designer to produce a tool that is accurate and also inexpensive to make and to maintain in operating condition, and very few companies will now take the risk of making solid dies on account of the danger of their cracking during the hardening and tempering process. The die shown in Fig. 1 is made in sections, so that all the cutting edges and the inside of the die can be machined and ground to the required dimensions without requiring any hand work. This construction makes the punch and die inexpensive to produce, and in event of its being damaged during the hardening process or when placed in operation, the damaged parts can be renewed at a relatively small cost. The punch and die are used in manufacturing laminated copper washers for which there is a demand of several thousand a day. These washers are square with a square hole in the center and are produced from sheet copper 0.020 inch in thickness. An inclined power press with automatic roll feed is used, and the finished work slides into a receptacle at the rear of the press.

Fig. 1 shows plan and sectional views of the die, from which it will be seen that there are three piercing and three blanking dies carried on one bolster. The die is made up of fifteen sections which are held together by double dovetail plugs fitting into corresponding holes. When ribbon stock is fed through the die, the holes in three washers are pierced at the first stroke of the ram, and at the next stroke the blanking punch cuts away three washers with the holes in their centers which were produced by the preceding stroke; at the same

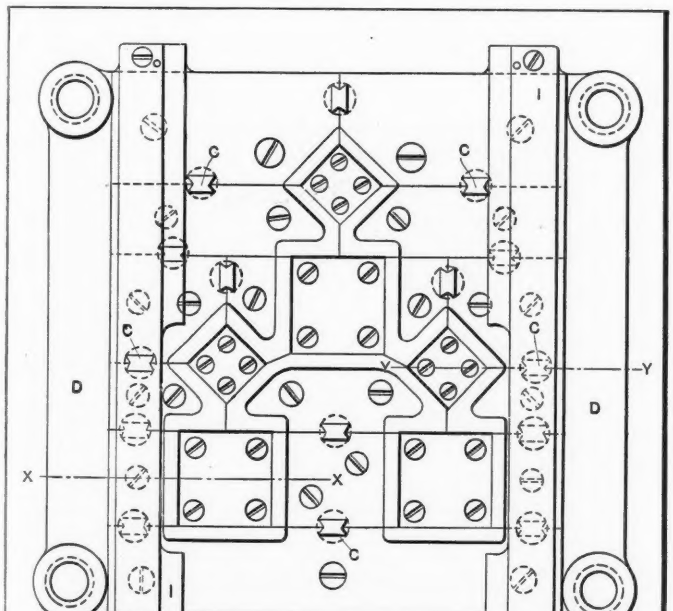


Fig. 1. Plan and Sectional Views of Blanking and Piercing Dies

stroke, the holes are pierced for the next three washers. None of the sections of the die have been drawn in detail as they will be readily understood from the assembly drawing. All of the die sections are machined approximately to the required dimensions with the exception of the inside or cutting edges, which are left a few thousandths over size to permit grinding them after hardening. The face is recessed on the outer edge to within ¼ inch of the cutting edge and ⅝ inch from the bottom, thus leaving a narrow strip all around the cutting edge in order to reduce the surface to be ground as far as possible. Each section of the die is held securely to the cast-iron bolster *D* with one or two fillister screws, and the sections are then wedged together with double dovetail blocks *C*. The cutting edge of each section is only hardened down about ⅜ inch and is drawn to a light straw color. When all the sections are assembled on the bolster *D*, the double dovetail holes are laid out with a templet and each of the sections is then milled with a dovetail cutter to receive the clamping blocks *C*. The blocks are made of tool steel, in strips 12 inches long; these strips are then sawed up into pieces ⅝ inch in length and the ends are filed to a slight taper so that they will just enter the holes between the die sections. These blocks are hardened in oil and drawn to a blue color. The die sections are next screwed to the bolster and the dovetail wedges are driven in; this method of fastening holds the die as securely as if it were a single piece.

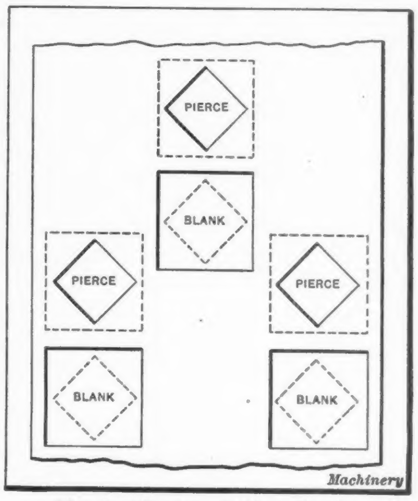


Fig. 2. Diagram showing Piercing and Blanking Operations on Ribbon Stock

Each of the piercing and punching dies is equipped with an ejector plate *E* which is a sliding fit in the holes and held in position with four flat head screws *F*. Spiral springs are placed around these screws to hold the ejector plates in position. The screws *F* extend through the bolster and carry adjusting nuts *G* which fit in counterbored holes on the under side of the bolster. Small holes are drilled in the under side of the bolster before the counterbored holes for the adjusting nuts are bored. These small holes are then plugged up to keep the drill from running out while counterboring the larger holes for the nuts *G*. When the plugs are removed from the small holes, the portion of the hole which was not removed during the counterboring operation serves as a guide in drilling a hole to receive the small pin *H* which is tapped into the nut *G* and keeps it from turning. The ejectors are adjusted by means of the screws *F* so that they are about 1/32 inch above the cutting edge of the dies. A long guide plate *I* is placed at each side of the die and fastened in position with fillister screws and a dowel pin on each end.

The cast-iron bolster plate *D* is planed on the bottom and top and also across the bosses. The four holes in each corner are next drilled, reamed and counterbored to receive the sub-press pins *J*, similar holes being made in the punch holder after the punch and die have been assembled. The sub-press pins *J* are made of tool steel hardened up to the head; the heads are ground to a driving fit in the die bolster and the pins are ground to a sliding fit in the punch holder. To locate the holes for these pins in line with each other, and also to have them square with the punch and die, the following method was used: After the punch and die were hardened and assembled, two parallels were placed between the bolsters. The punch was placed inside the die and the punch and die clamped together with four C-clamps. After the work had been clamped in this way the holes were bored in the punch holder through the holes in the die bolster, and were consequently in perfect alignment.

Fig. 3 shows plan and sectional views of the blanking and piercing punches *A* and *B*, which are made of tool steel and left soft. These punches are secured to the cast-iron holder *C* by means of two fillister screws and two dowel pins. In order to locate the punches in proper alignment with the die, the punches are first marked so that they can be replaced in the same positions. The ejectors are then taken out of the die and blocks made of ¾-inch cold-rolled steel are placed in the

* Address: Rockfall, Conn.

die holes in their places. These parallel blocks are faced off to the proper height to bring them 1/16 inch below the cutting edge, all six of the blocks being of the same height. The punches are next placed in their respective die holes and the punch holder *C* is then slipped over the four sub-press pins in the die bolster and lowered onto the punches. With a right angle scratch-awl, lines are marked on the punch holder to locate the four sides of each punch, the scriber being worked through the screw holes in the die bolster. The punch holder is next withdrawn, and from the outlines of the punches on the holder the four holes for each punch are located, drilled and counterbored to receive the two set-screws and the two dowel pins. When all of these holes are drilled in the holder, the latter is once more replaced on the punches and secured with four C-clamps. Care must be taken not to twist the punches and also to see that the two bolsters are parallel with each other. All of the screw and dowel pin holes are now drilled into the punches to a depth of about 1/32 inch, the holes in the punch holder serving as a guide. The C-clamps are now loosened and the punch holder removed; all of the

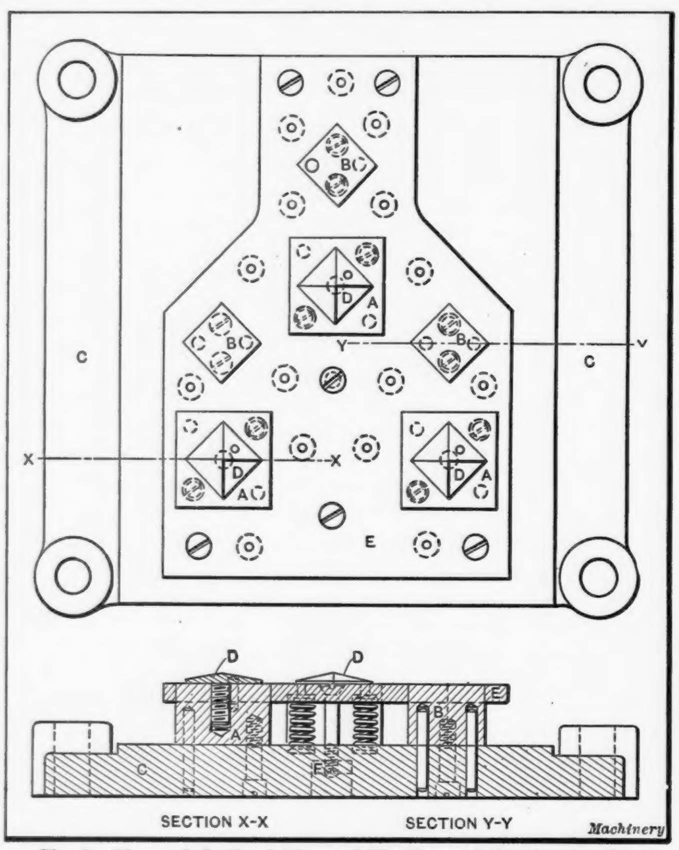


Fig. 3. Plan and Sectional Views of Blanking and Piercing Punches

punches are then taken out of the die and the holes are drilled to the required depth, after which the screw holes are tapped. When this work has been finished, the punches are replaced in their respective positions on top of the blocks in the die. Care must be taken to have all the chips removed and the work perfectly clean. The punches are secured with screws and the two bolsters again strapped together with four C-clamps; straight dowel pin holes are then reamed through the bolster into the punches. In that way all of the punches and sub-press pins are in perfect alignment.

Pilots *D* are screwed on top of the three blanking punches to guide the metal during the blanking operation. These pilots enter the holes in the washers which were pierced by the preceding stroke of the ram, and prevent the work from twisting. These pilots are held in place by a screw and a dowel pin. A stripper plate *E* made of 5/16-inch cold-rolled steel surrounds the punches and is held in position by the tension of fifteen springs. This stripper plate is made to fit between the guides *I* on the die and is a free fit on the outside of the punches. The stripper plate is adjusted by the flat-headed screws and nuts *F*. It will be noticed that there is a small hole in the center of each spiral spring seat. These holes are made in the following manner: All of the holes in the stripper plate are laid out in the usual way and drilled through with a ⅛-inch drill; the stripper is then placed on the bolster with all of the punches in position and the holes are transferred through onto the bolster. The spring seats can now be counterbored on the stripper and bolster and by this means all of the spring seats will be in perfect alignment with each other.

* * *

BLANKING AND DRAWING A LARGE STEEL CUP IN ONE OPERATION

A good example of deep drawing is shown by the accompanying illustrations, the work being an outside jacket for the Stuart & Clark automobile speedometer. This jacket, which is

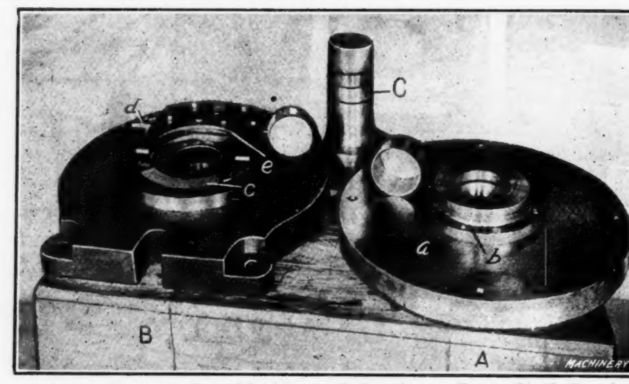


Fig. 1. Tools used in blanking and drawing a Large Steel Cup in One Operation

3 3/16 inches outside diameter by 2 7/16 inches deep, is made from 0.042 inch deep drawing sheet steel, and is formed from a blank 6¾ inches diameter in one operation in the double-action press shown in Fig. 2. The dies, punch and work are illustrated in Fig. 1, where the construction of these tools is clearly shown. At *A* is shown the blanking die which is held, when in use, to the base of the ram of the press, as indicated in Fig. 2. This consists of an iron casting *a*, to which the cutting die *b* is fastened by screws and dowels.

The combination blanking and drawing die is shown at *B* and consists of the regular cast-iron bolster in which is inserted the cutting die ring *c*, having an irregular top cutting face. The stock is located by the guide *d* and the blank is stripped from the punch by the stripper *e*. The punch used, which is shown at *C*, is held in the double-action part of the press. The drawing die is rounded well on the top, giving a slight mouth taper and is then made straight so that the work is forced completely through it, dropping into the box placed under the press. This job is being handled successfully in the Chicago plant of the Stewart-Warner Corporation.

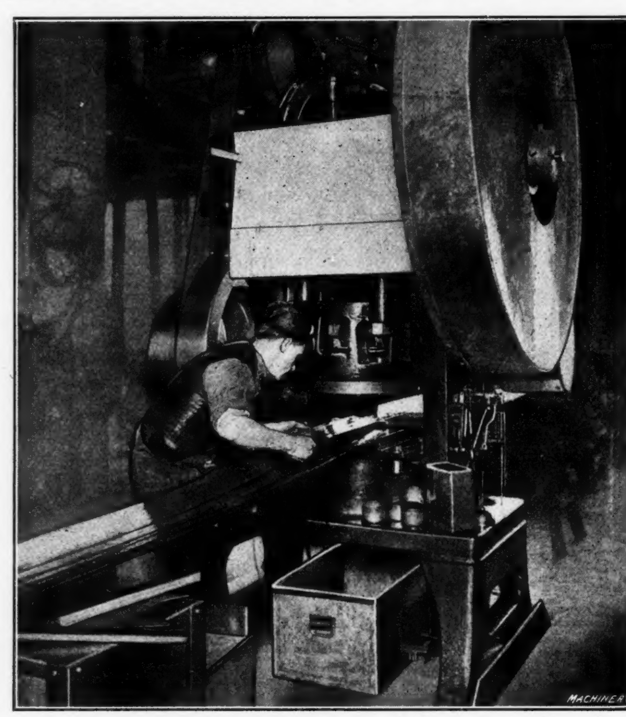


Fig. 2. Double-action Punch Press in which the Tools shown in Fig. 1 are used

D. T. H.

BROACHING A VACUUM CLEANER PART

BY RALPH R. LAPOINTE*

During recent years, a considerable amount of information has been published on broaching machines and their application on different classes of work. The following description of the method of broaching a vacuum cleaner part illustrates the facility with which the Lapointe Machine Tool Co., Hudson, Mass., handles operations of this nature. Fig. 1 shows one of the blanks from which these parts are made, a finished part and the broach which is used for this operation. A better idea of the nature of the work will be gathered from Fig. 2, where a piece is shown in course of development from the rough forging at *X* to the finished part at *Z*. These

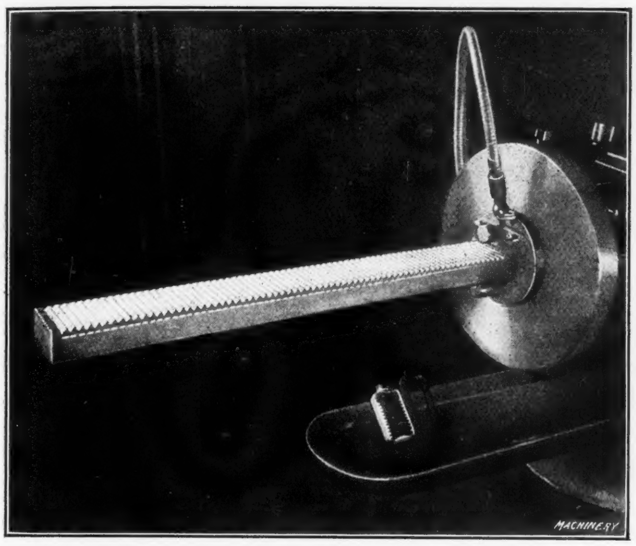


Fig. 1. The Broach and Vacuum Cleaner Part it is used to finish

pieces consist of light drop-forgings that have edges shown at *A* which make them rather difficult to hold. The thinness of the metal at *B* also provides very little abutment to withstand the strain of heavy broaching. Referring to the illustration of the finished piece shown at *Z* in Fig. 2, it should be remembered that not only are the rack teeth cut, but also the clearance at *C*, the angular teeth *D* and the end surface *E*, all of these surfaces being finished at one passage of the broach. In finishing these pieces, it is necessary to have the center line *F-F* concentric with relation to the end surfaces *E* and this feature was easily provided for through finishing the pieces on the broaching machine. If the surfaces *E* had been machined by separate operations on any other machine than a broaching machine, there would be a possibility for the introduction of an error at this point.

It will be seen that the pieces are approximately ½ inch thick and that they have a draft *H* on the inside of the forging. The amount of material removed at the dimension *J* was 0.198 inch on each side. The broaching operation would have been easier to handle if this draft had not been necessary. Attention is also called to the fact that the rack teeth were machined with a degree of accuracy which held the dimension *K* within a limit of 0.002 inch, which is exceptionally close when the lightness of the work is considered. After the first two thousand pieces had been broached, the first and last pieces of the series were checked in order to determine if any wear had developed in broaching. There was not any error between the dimensions of these two pieces which could be measured. It is stated that in broaching this first series of 2000 pieces, a saving of 80 per cent was made over the time that would have been required to manufacture them by any other method; this saving is net, the cost of the broaches being included in the cost of production.

The broach is made so that the rough forging shown at *X* is first machined to the outline shown at *Y* in Fig. 2. After this section was obtained, the clearance at each end, the teeth and the angular cut on the teeth *D* were machined. The gear tooth section was given very little clearance, so that the broach could be sharpened at the front of the teeth. This greatly increased its life. This broach would machine at least 6000 pieces at a rate of production of about 30 pieces per hour.

* Address: Lapointe Machine Tool Co., Hudson, Mass.

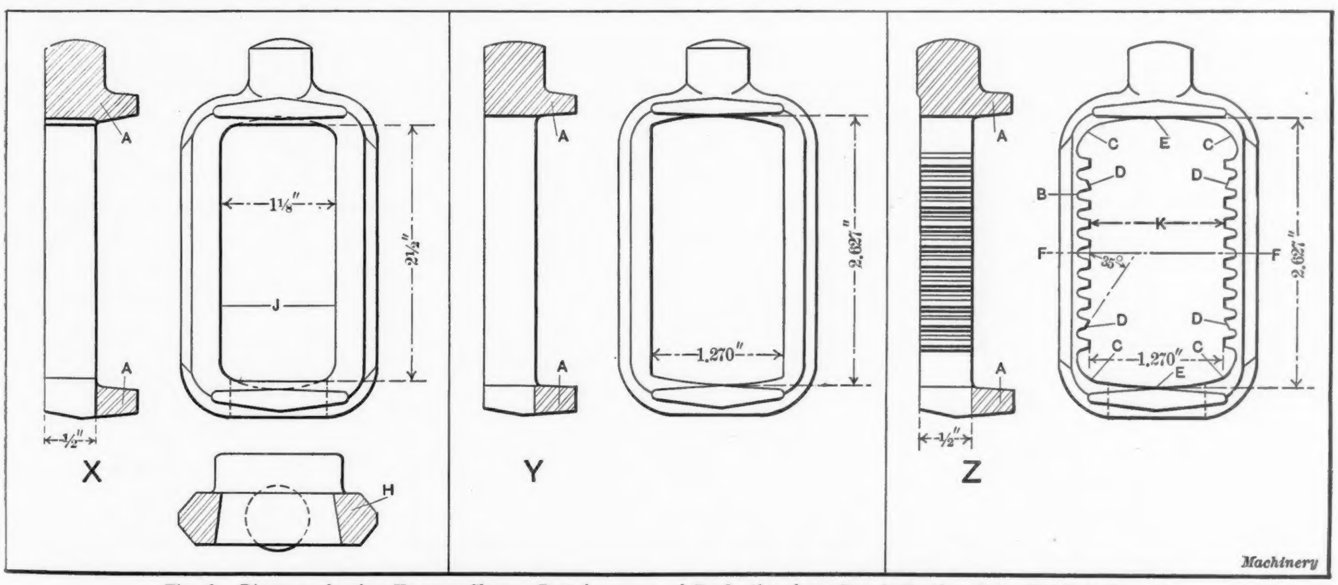


Fig. 2. Diagram showing Vacuum Cleaner Part in course of Production from Rough Forging X to Finished Piece Z

* * *

In a report from Consul Douglas Jenkins, the results of the use of ball bearings on railway cars in Sweden, are referred to. About two years ago, one of the smaller private railroads in Sweden began testing ball bearings in railway traffic, one passenger car being fitted with them for experimental purposes. This car has since been used in regular traffic and the management of the road finds that the ball bearings have given entire satisfaction. It is estimated that the operating cost is reduced at least seven per cent by the use of ball bearings, and there is also a considerable saving in lubricants and cost for attention to the bearings. This railway company has sent in a further order for ball bearing equipment, and another railway company has also decided to adopt ball bearings on passenger equipment. The Swedish State railroads recently applied ball bearings to a coach running in the express train traffic between Stockholm and Gothenburg. The first experiment having proved satisfactory, the State railways have given orders for more ball bearing equipment for railroad cars and intend to make a thorough and systematic test.

* * *

The New York Central and Hudson River Railroad Co. has recently placed an order with the General Electric Co., Schenectady, N. Y., for nine electric locomotives. The weight of these locomotives is to be 100 tons each and they will exert sufficient tractive effort to haul a train weighing over 1000 tons at a speed of 60 miles an hour. In regular service they will have a capacity for developing 1400 horsepower continuously or as high as 500 horsepower for short periods.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE LODGE & SHIPLEY "SELECTIVE HEAD" LATHE

To combine strength, simplicity and durability, the selective type of automobile transmission has been adopted by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, for the gear box drive of its new "selective head" lathe. This permits any one of the spindle speeds to be selected instantly —hence the name "selective head." A constant-speed single driving pulley running at a high belt velocity delivers ample power to the cutting tool under all conditions. As the diameter of the work increases, the gear ratios and the torque are proportionately increased. Thus lathe work requiring a maximum amount of power can be handled most advantageously by this machine. Power is transmitted through hardened steel gears mounted on shafts running in ball bearings. As the result of this and other refinements the selective head attains an exceptionally high mechanical efficiency.

only, to insure a powerful drive, and the friction will easily slip the belt. The ratio of the direct speed to the back geared speed is about 2.6 to 1. This is approximately the ratio between the finishing and roughing speeds on a given diameter of work; therefore, in order to increase the speed from a roughing to a finishing cut, the gear shift does not have to be made, it being only necessary to shift the friction lever from one side to the other. The friction pulley is entirely enclosed at its outer end to retain the oil. A combination oil and belt guard is provided at the inner edge to prevent throwing oil on the belt.

All gears within the gear box are of the stub-tooth 20-degree pressure angle type. They are made from chrome-nickel steel, heat-treated and hardened. After hardening, the bores of the gears are ground concentric with the pitch circles, and the gears are finally mounted on an arbor in a special machine where the teeth are lapped, so that any dis-

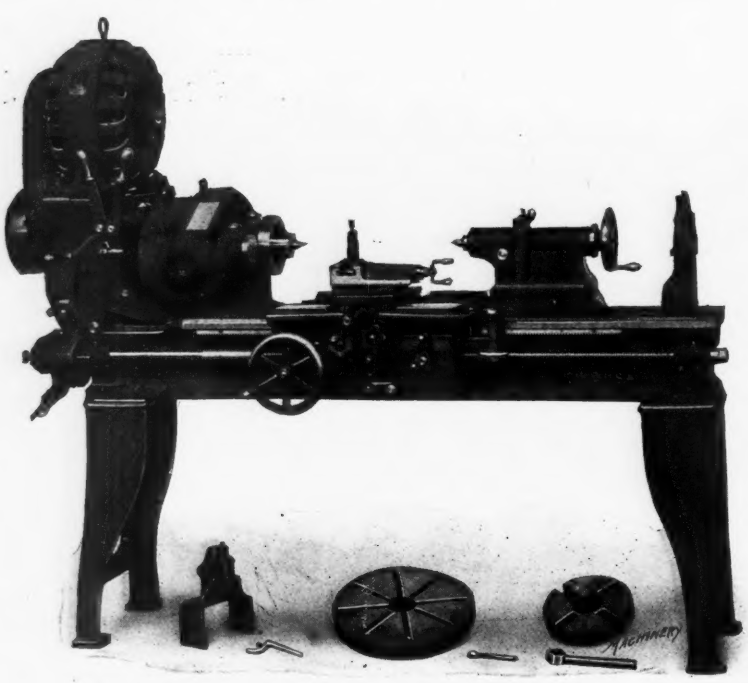


Fig. 1. Lodge & Shipley 14-inch Selective Head Lathe

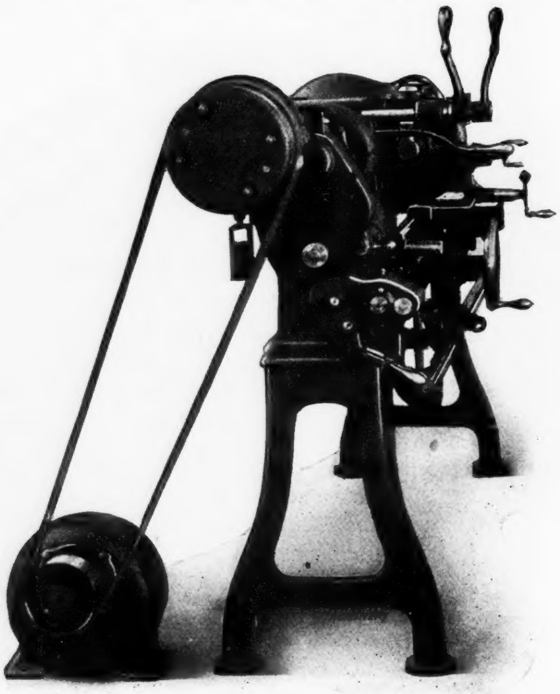


Fig. 2. 16-inch Selective Head Lathe with "Simplicity" Motor Drive

The headstock is made of box section, with the sides extended up to the center line of the spindle, which makes an unusually rigid casting. Further stiffness is added by internal bracing with both longitudinal and cross ribs. The back of the headstock is planed to receive the gear box which is made as a separate unit. There are six speed changes in the gear box. From the gear box the drive is either direct to the spindle or through shifting back gears in the headstock proper, giving twelve spindle speeds in all back geared lathes from 14- to 27-inch. The 30- and 36-inch lathes can be provided with triple gearing and this gives eighteen speeds. These two sizes are also built without triple gearing, and they then have twelve changes of spindle speed. In the triple geared lathe there are six speed changes by direct drive from the gear box, another six changes through the back gears, and the third set of the six slowest speeds is obtained through the triple gearing driving into the internal gear of the faceplate. On the 42- and 48- inch machines the triple gearing is always supplied in order to provide speeds sufficiently low to accommodate large diameters.

An extended flanged hub attached to the gear box carries the driving pulley and thus relieves the driving shaft of all belt pull. Inside the pulley are two frictions, one of which drives the initial shaft direct, while the other drives it at a back geared speed. The friction is at the initial point

tortion produced in the hardening is removed. This insures perfectly true gears, easy rolling action and noiseless operation. All of the transmission gears in the gear box are made from chrome-nickel steel, heat-treated and hardened. This gives a tensile strength of about 260,000 pounds per square inch, an elastic limit of about 240,000 pounds per square inch and a scleroscope test of "seventy degree" hardness. This produces a gear of fibrous structure and exceptional strength and resiliency. It not only results in practically indestructible gearing, but also reduces the frictional loss in transmission because of the great hardness of the gear teeth and the excellent wearing surfaces which they present to each other.

The entire speed changing mechanism, except the back gears of the headstock, is contained in the gear box which is an independent unit tongued and bolted to the back of the headstock. It may be removed at any time without affecting the other parts of the head, or without removing the motor, if a motor drive is used. The gear box is oil-tight and dust-proof, and the gears run at all times partly submerged in oil. The initial shaft of the gear box, which has either direct or back geared speed, transmits power to the driven shaft through sliding gears. The initial shaft in the gear box which receives the sliding gears has four keys formed upon it. There are no screws or cotter pins inside the gear box, nor any other small parts which might work loose and get into the

running gears. Both shafts in the gear box in all sizes of lathes are mounted in anti-friction ball bearings. Threaded dust plates retain the ball bearings in their respective seats and exclude dirt or grit from both the ball bearings and the gear box. No shaft runs at a higher rate of speed, even in the small lathes, than 375 R. P. M. This comparatively low rate of speed and the anti-friction properties of the ball bearings help maintain an exceptionally high efficiency of transmission.

The six speeds provided by the gear box are obtained through two vertical levers, conveniently located on the front of the headstock. The lever nearest the operator controls the two frictions in the driving pulley and stops, starts and gives fast and slow speeds by moving the lever to the right or left. The other vertical lever shifts the gears and must be moved to the right or left and also in or out to select the required gear. The horizontal lever operates both a positive stepped clutch on the spindle and the sliding back gear pinion which is interlocked with the clutch so that both cannot be engaged at the same time. A plate on the front of the headstock gives a complete list of all speeds and the position of levers for obtaining them.

The back gearing is located at the front of the headstock. The back gear shaft and pinion in lathes from 14- to 36-inch sizes are cut from a single steel forging. The teeth of the pinion are hardened and the shaft is journaled in continuously lubricated bronze bushings. The triple gear is operated by a handwheel which slides the triple gear pinion into or out of mesh with the internal face gear. All headstock driving gears are of steel, and as previously explained, gears subjected to the most wear are of chrome-nickel steel heat-treated and hardened. On all lathes, the gearing is designed to give a practically uniform speed progression throughout the entire speed range.

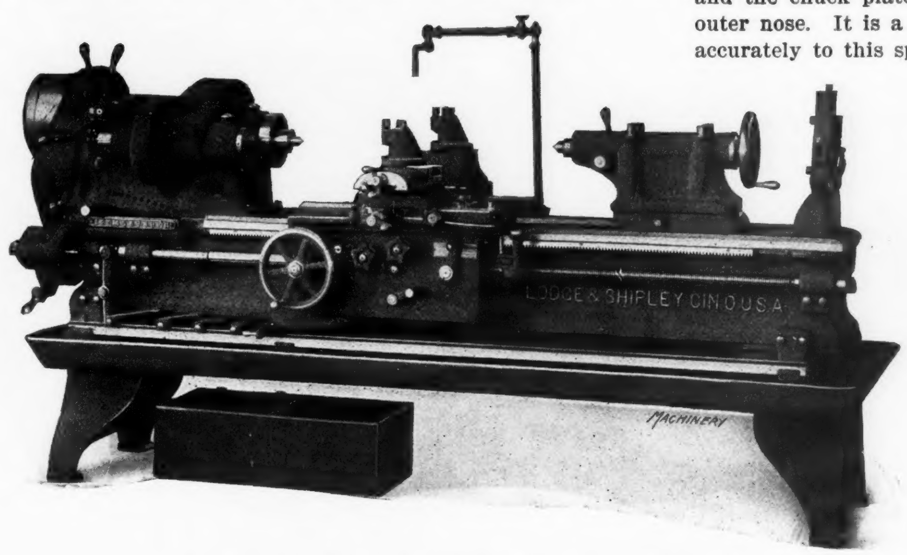


Fig. 3. Belt-driven 18-inch Lodge & Shipley Selective Head Lathe

The spindle is of large diameter and made from chrome-nickel steel. The end thrust is taken against the rear housing by alternate bronze and hardened steel thrust washers, and the spindle bearings are of special composition white metal, renewable, interchangeable, and continuously lubricated by wick oilers from large oil wells. These white metal bearings are faced and turned in halves to exact gage size; the headstock casting is reamed to the same size, and the screw holes are drilled in a jig. The spindle has a double nose, consisting of an inner cylindrical portion and an outer cup. The cup is threaded internally to hold the chuck plate in position and the end is faced to provide a very large diameter shoulder against which the faceplate is tightened. The inner cylindrical portion of the nose is left blank and extends beyond the outer nose to form a pilot to receive the faceplate or chuck plate. This pilot at all times accurately centers the chuck plate, and by centering the bore of the chuck plate before the threaded portion is reached insures having the threads engage easily and the chuck plate drawn squarely against the face of the outer nose. It is a comparatively easy matter to fit a chuck accurately to this spindle, as the bore may be reamed to the standard size to fit the pilot and the thread is only used to hold the plate in position against the face of the cup. The threading of the chuck plate is easily done, as it is a job of external chasing. The large diameter of the shoulder afforded by the cup prevents the faceplate from becoming stuck to the spindle nose and makes it always an easy matter to remove the faceplate or chuck. Spindle noses of selective head lathes from 14- to 20-inch are made to the same standard, so that chucks will interchange from one lathe to another between these sizes. Similarly, another standard is used for all lathes from 22- to 36-inch. As the larger lathes are triple geared, there are but the two sizes of spindle noses for the entire range of lathes.

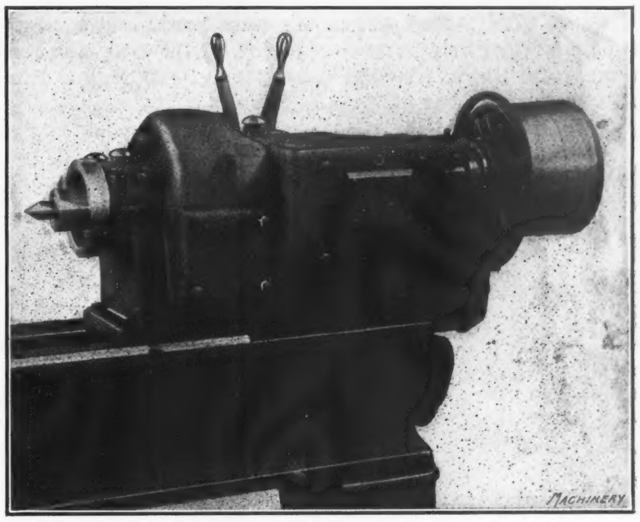


Fig. 5. Rear View of Lodge & Shipley Selective Head Lathe

No countershaft is necessary with this lathe if the machine can be placed near the lineshaft, and the drive may be secured from either a straight or quarter turn belt. If a countershaft is required, either a single speed plain tight and loose pulley countershaft or a double friction countershaft may be used. Any standard make of motor, either direct or alternating current, constant or variable speed, within reasonable limits of size and speed can be mounted on the top of the headstock

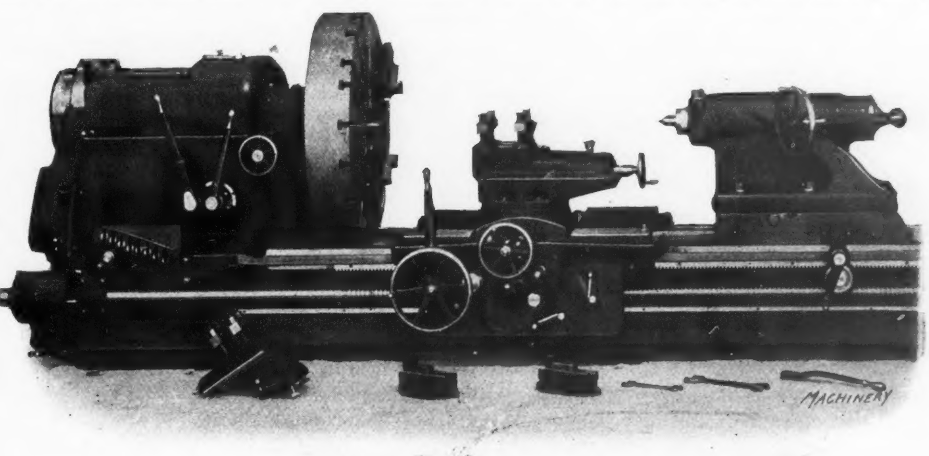


Fig. 4. Lodge & Shipley 48-inch Selective Head Lathe

and direct connected through gearing. A gear which contains the same friction mechanism as the pulley is substituted for the pulley at the end of the gear box, and a suitable casting is mounted at the end of the headstock cover and carries an intermediate fiber gear running in positively lubricated journals. This casting serves as a gear guard and cover for all of the motor drive gears. A pinion on the armature shaft meshes with the intermediate fiber gear, thus giving a direct drive to the gear box of the headstock. At any time, a regular belt-driven selective head lathe may be driven from an

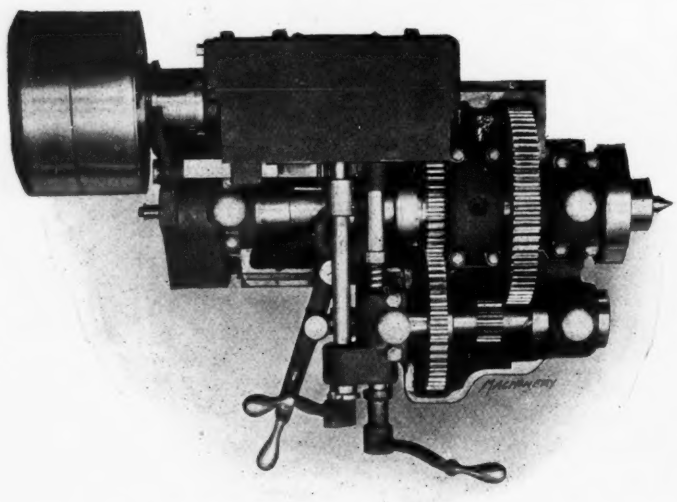


Fig. 6. Interior of the Lodge & Shipley Selective Head

individual motor placed on the ceiling or on the floor and connected to the headstock pulley by a belt. This constitutes the "simplicity" motor drive illustrated in Fig. 2. A constant-speed motor is generally used for this style of drive.

The bed is made from close grain iron of high tensile strength, and the top is cast against a chill which makes the top of the bed hard and dense, greatly lengthens the period of accurate alignment, and so closes the pores that dirt and grit cannot become imbedded in the ways to wear the carriage by a lapping action. The tailstock has floating binders to insure correct alignment of the tailstock spindle, an exceptionally long spindle of tool steel, and the barrel extended beyond the face of the tailstock to afford a firm support to the spindle at all times. The clamping bolts for holding the tailstock to the bed are operated from the top of the barrel. In 22-inch lathes and larger, a pawl on the base of the tailstock engages the rack in the center rib of the bed to afford a positive brace.

The quick change gears for feeds and threads are of drop-forged steel, located beneath the headstock and firmly sup-

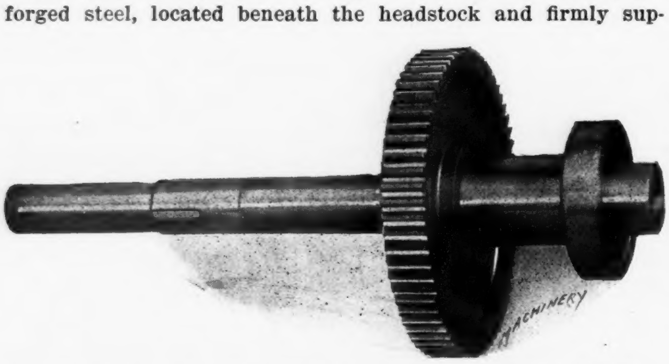
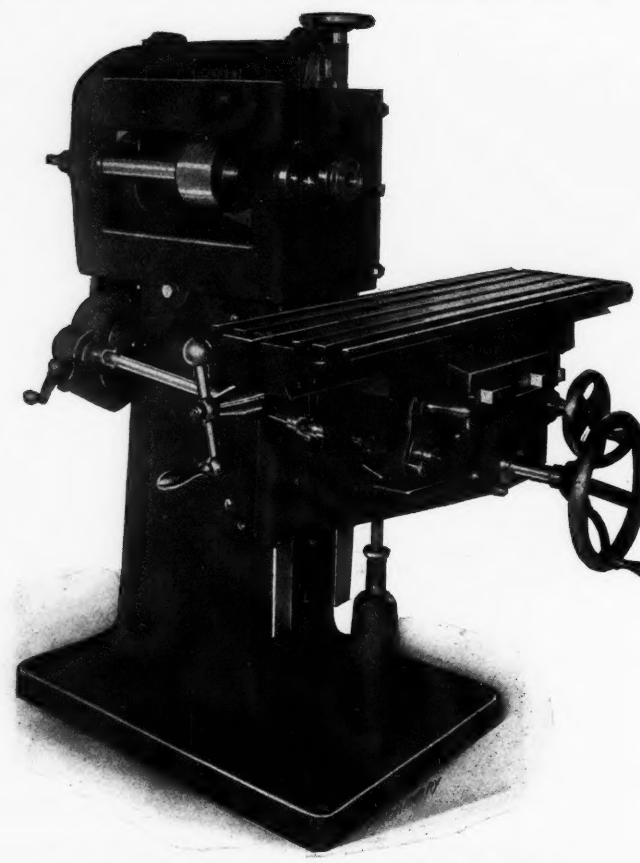


Fig. 7. Spindle and Face Gear of Lodge & Shipley Selective Head Lathe

ported in the walls of the bed. Changes of feed or thread can be quickly made while the lathe is under cut. The carriage is gibbed inside and out; it has an oil trough around the front and rear wings and the extra wide bridge takes a supplementary scraped bearing against the inside horizontal and vertical flat surfaces of the bed, thus providing a positive support directly in line with the tool thrust. The compound rest has a special square base so designed that the top slide cannot be overhung, which provides a solid metal-to-metal anvil support under the tool to prevent any vibration. The apron is self-contained and double walled, with studs supported front and rear. All gearing except the frictions is of steel, and a stub tooth rack pinion insures adequate strength. Manufacturing equipment consisting of multiple stops for length and cross feeds, connected compound and plain rests, pan pump and tubing and a four-way tool block can be furnished with any of these lathes. These are valuable additional appliances for turning repetition work.

GARVIN MILLING MACHINE WITH ROUGHING SPINDLE

The illustration shows the No. 13 size of plain milling machine manufactured by the Garvin Machine Co., Spring and Varick Sts., New York City, equipped with an auxiliary spindle for taking a roughing cut. This roughing spindle works ahead of the regular spindle and its use has been found a valuable time saver, as both the roughing and finishing cuts are taken

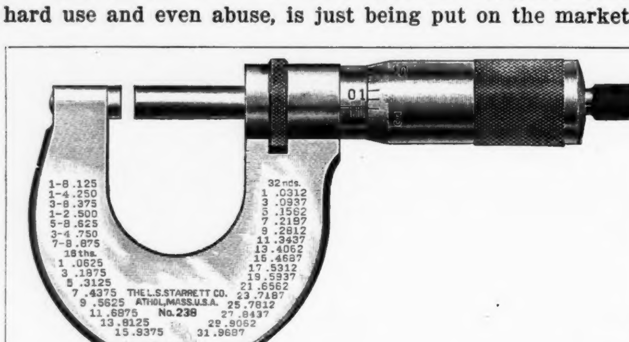


Garvin No. 13 Plain Milling Machine with Roughing Spindle

without requiring more than one setting of the work. The roughing spindle has a 1-inch vertical adjustment and is driven from a separate countershaft. The automatic table feed is 24 inches, the in and out adjustment 7 inches, the vertical adjustment 19 inches and the weight of the machine 1900 pounds.

HEAVY STARRETT MICROMETER

A micrometer which has been specially designed to stand hard use and even abuse, is just being put on the market by



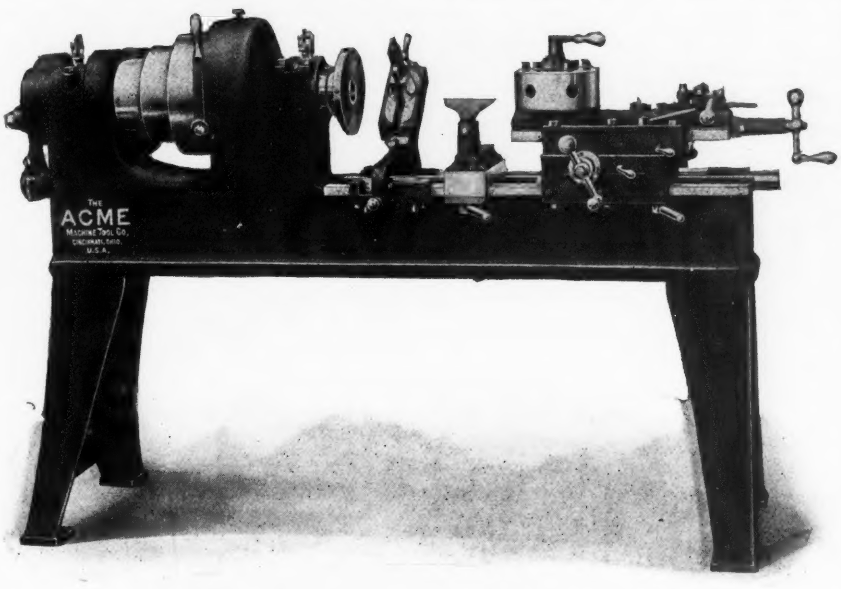
Starrett Micrometer adapted for Hard Usage

the L. S. Starrett Co., Athol, Mass. This micrometer does not embody any new mechanical features but is simply made

much heavier than other micrometers, the idea being to furnish an instrument which machinists may use for general purposes. The large bearing surface for the screw threads and the heavy construction of the frame give a micrometer which will outlast anything which is now made. It is provided with a Starrett ratchet stop and lock-nut and has hardened contacts to minimize the wear. Decimal equivalents are stamped on the front.

ACME 16- AND 18-INCH UNIVERSAL TURRET LATHE

The illustration shows a universal turret lathe which has been brought out by the Acme Machine Tool Co., Cincinnati, Ohio. This machine is made in 16- and 18-inch sizes and equipped with a geared friction head, chasing attachment and hand rest. All bearings in the machine are accurately ground and hand scraped and all operating levers are placed within easy reach of the operator.



Acme Universal Turret Lathe provided with Geared Friction Head

The head is cast solid with the bed and is provided with friction back gears giving two speeds for each cone step. By having the head cast integral with the bed it will be obvious that the maximum rigidity is secured. The spindle is made of high carbon hammered crucible steel and runs in babbitt bearings which may be readily renewed when necessary.

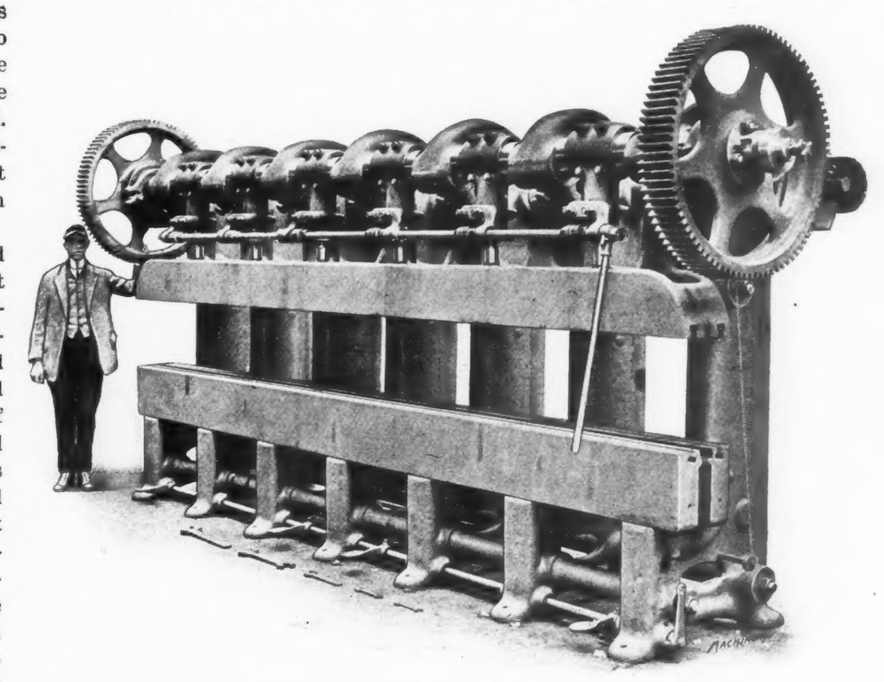
The turret is round in form and provided with six tool holes fitted with set-screws. It is arranged so that stock up to the full diameter of the hole can pass through the turret, thus allowing short stiff tools to be used for turning long work. The turret is indexed automatically by the backward movement of the turret slide, and the locking bolt is placed at the front end of the slide where it works in hardened and ground taper bushings located near the outer edge of the turret. The turret slide is provided with swivel and set-over adjustments. Both lever and screw feed are furnished for the longitudinal movement of the slide which is graduated for swiveling and provided with an adjustable stop. The set-over movement of the turret is obtained by means of a bell crank handle and a screw with a large micrometer dial to insure obtaining exact diameters. The stop for determining the central position of the turret can be shifted to allow the turret to pass beyond the center in either direction. Taper gibs on both sides of the slide provide means for taking up side wear. The saddle rests on an adjustable taper base insuring perfect alignment between the holes in the turret and the spindle. A binder handle on the front of the saddle provides for clamping it to the bed.

The chasing attachment is arranged for chasing straight or taper threads either right or left hand, the same leader and follower being used in all cases. Three leaders and one three-prong follower are provided with the lathe for cutting $11\frac{1}{2}$, 14 and 18 threads per inch. The hand rest saddle with two hand rests of different lengths is also included as a part of the regular equipment. The machine shown in the illustration is arranged to be driven from a double friction countershaft with ring oiling bearings, but when desired the lathe can be arranged for electric motor drive.

FERRACUTE PRESS

The Ferracute Machine Co., Bridgeton, N. J., has recently built several presses similar to the machine illustrated herewith. The frame of this machine is composed of seven columns or housings—all exactly alike—and the ram is connected to the crankshaft by six pitmans each having its own pitman strap and ram adjustments which practically makes six presses in one. The important advantage secured from this form of construction lies in the fact that it is possible to construct a press of any length within reasonable limits by merely adding or subtracting the required number of units. The shaft, bed, ram and tie-rods are the only parts of the press which are affected by the length.

Presses of this type are suitable for bending or forming long lengths of structural material and are also adopted for punching long strips or sheets. They may also be used to advantage in connection with subpresses. Treadles may be arranged anywhere that they are needed along the treadle shaft (the illustration shows a machine provided with four treadles) which enables the operator to start the press from any desired position. Torsional stresses in the long crankshaft are reduced to a minimum by having a gear at each end; these gears have cut teeth. All of the pitmans are adjusted at the same time by means of a horizontal worm shaft acting simultaneously on a worm-wheel on the pitman stems, the shaft being actuated by a ratchet lever which will be seen in the illustration.



Ferracute Press with Frame built in Sections

The slots in both bed and ram are carefully planed to insure accurate alignment of the dies which may be clamped at any point along the bed. There is a clutch at each end of

the press, the action of these clutches being simultaneous. Holes are provided in the bed between each pair of columns to allow the punchings to drop through. The ram is gibbed to each column and has a stroke of 2 inches but a longer stroke may be provided if necessary. The adjustment of the ram is up to 3 inches. The shaft is made of high carbon steel and is 5 inches in diameter at the cranks and 4 inches at the journals. The press is driven by two 30-inch flywheels on the backshaft, each flywheel having a weight of 475 pounds. The total weight of the machine shown in the illustration is about 29,300 pounds.

QUINT TURRET DRILL

The illustrations show a six-spindle vertical turret machine with rotating spindles which has recently been placed on the market by A. E. Quint, Hartford, Conn. This machine has been designed to facilitate the performance of successive operations on work which must be drilled, reamed, counterbored and tapped, and as all of the operations can be performed at one setting of the work, a considerable saving of time is effected.

A projecting knee is cast on the lower part of the column of the machine. A two-jaw universal chuck is fastened to this knee, the chuck being provided with a capstan wheel on the screw to provide for opening and closing the jaws. The capacity of the chuck is for work up to 12 inches in diameter, and it is so arranged that it may be operated on or off the center. Adjustable buffer plates are provided on the top of the chuck and also on top of the baseplate of the machine which serve to guide the work while it is being clamped in the chuck. It will be seen that the baseplate is made with a slot 14 inches in width extending right through to the front

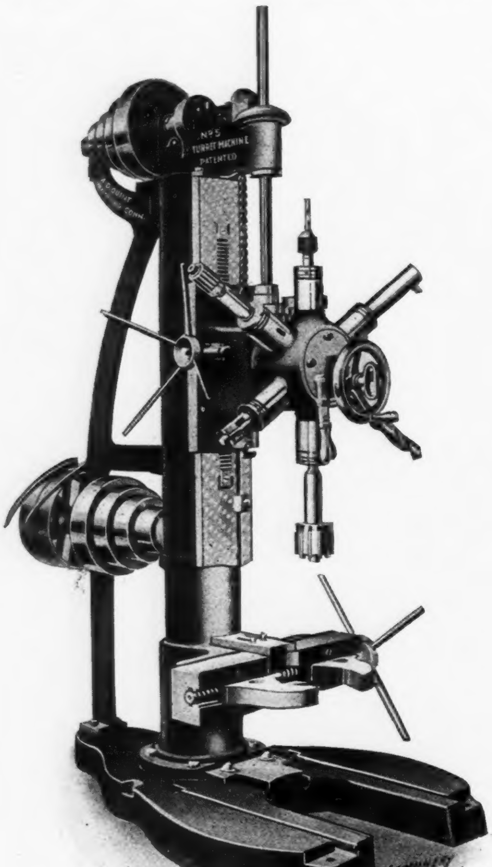


Fig. 1. Left-hand Side of Quint Turret Drill

of the base. This allows long pieces to be operated on, the length being limited only by the depth of the pit which is provided under the machine.

The machine which is the subject of this description is known as the No. 5 pattern. The sliding head is balanced by a weight inside the column. This head carries the feeding mechanism, the locking index and the steel spur gearing for transmitting motion from the vertical driving shaft to the rotating spindles in the turret head. It will be seen that the six-spindle turret is mounted on the sliding head, the turret being free to rotate on the head. Any spindle which is required may be swung into the working position without stopping the machine by means of the lever shown on the front of the turret. When this lever is swung to the right, it releases the index bolt; the turret is then rotated to bring the required spindle into the operating position; the lever will

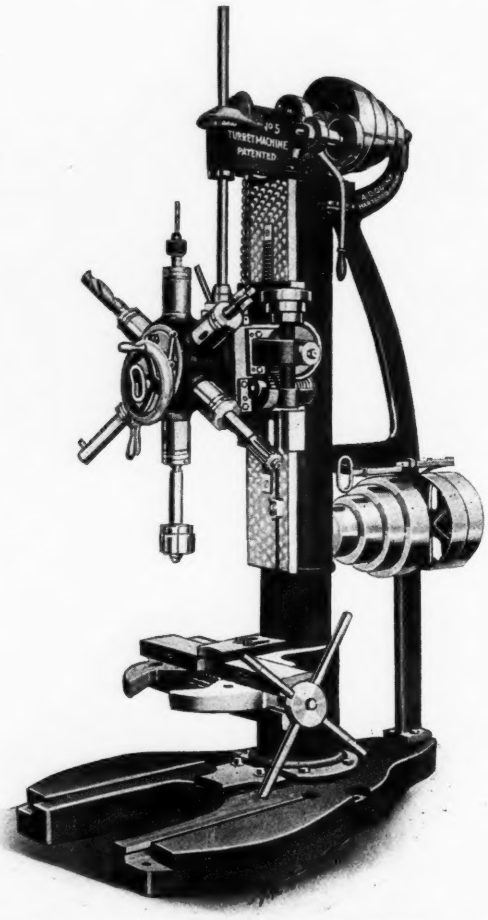


Fig. 2. Right-hand Side of Quint Turret Drill

then automatically lock the turret in place. The spindle in the operating position is the only one which revolves.

The hand feed is operated by means of the handwheel at the front of the turret, and the power feed is operated by a belt and cone pulleys on the sliding head, the power feed being started and stopped by means of the handle at the front of the handwheel which controls the hand feed. The power feed can also be tripped by means of the stop shown in the slot in the face of the column of the machine. This stop may be adjusted for any depth of hole up to 28 inches. The quick return of the head is effected by means of the pilot wheel on the left-hand side of the machine which operates a pinion in mesh with the rack in the face of the column. The lever for connecting the back-gears may be operated while the machine is running.

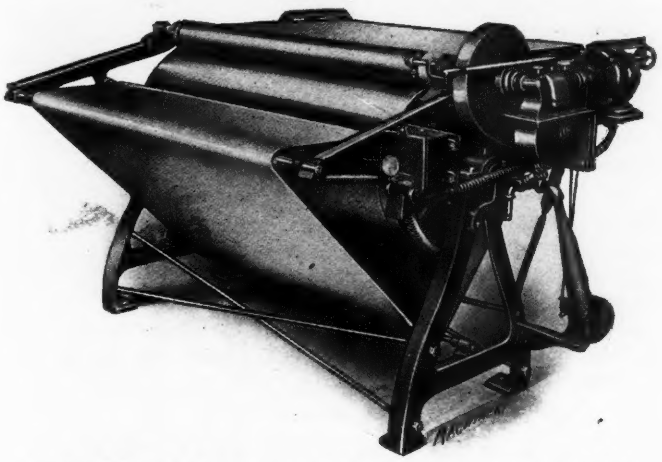
The machine is 8 feet high and occupies a floor space of 3 feet 4 inches by 6 feet. The distance from the face of the column to the spindle is 16¼ inches. The turret head is made with either four or six spindles, the spindles being reamed to No. 4 Morse taper. The total weight of the machine is 4000 pounds.

AMERICAN BLUEPRINT IRONER

The blueprint ironer illustrated herewith is a product of the American Laundry Machinery Co., Rochester, N. Y. This machine does away with the necessity of hanging blueprints up to dry after they have been washed, and blueprints dried in this way are not only available in less than one minute after they have been washed, but they also come out of the ironing machine perfectly smooth. The latter consideration is of particular value in filing, as the space required by flat prints is far less than that which is taken up by prints dried in the ordinary way. In addition, the tendency of the prints

to become distorted in drying is eliminated, and this means that the danger of errors in scaling from the print will be reduced.

The machine consists of a 20-inch cast-iron roll which is supported by substantial end frames held together by tie-rods. The cast-iron roll is heated by either gas or steam, and a multiple fabric apron runs over it. A blueprint which is to be ironed is placed on this fabric belt and carried with it underneath the heated roll which moves at the same speed as the



American Blueprint Ironer which dries Blueprints quickly and without Distortion

apron. After the print has been carried under the roll, it is separated from the roll by means of the curved metal guard which is shown in the illustration. The blueprint then falls back onto the apron and is carried on to the opposite side of the machine. As the speeds of the roll and apron are the same, there is no frictional resistance to mar the surface of the blueprint paper. The print comes out thoroughly dried and ironed quite smooth. A simple hand lever is provided which allows the apron to fall away from the heated roll when the machine is not in operation. The adjustment of the apron is provided for by a set of hand screws so that there is no trouble in having it run true at all times. These machines are built in two widths, having heated rolls of 46 and 60 inches in length. The illustration shows the blueprint ironer equipped for electric motor drive, but belt drive may be employed if the user so desires.

MUMMERT-DIXON CRANE GRINDER

The machine illustrated herewith is a product of the Mummert-Dixon Co., Hanover, Pa., and has been designed to facilitate grinding those classes of work which are too large and heavy to be handled in the ordinary way. It will be seen that the machine is virtually a grinding stand combined with a power jib crane, and the advantageous features of this combination will be readily apparent to those who have heavy castings to grind.

In handling castings which are too heavy to be lifted by hand, the crane is used to support them at the proper height from the floor and at the proper distance from the wheel. It is then only necessary for the operator to swing the work against and along the wheel. As he is not required to do the heavy work that is necessary in lifting the castings into position, he is able to turn out a great deal more work in the course of a day.

The hoist is operated by power controlled by a lever which is conveniently located in relation to the operating position. Provision is also made for operating the hoist by hand, a crank handle which fits on the end of the shaft being provided for this purpose. The hoist trolley is mounted on the jib and driven by a square shaft which receives power from the clutch pulleys through bevel gears. Two clutch pulleys are provided —one for hoisting and the other for lowering—which are driven by belts from the countershaft at the back of the machine. The hand lever previously referred to controls both clutches. Moving this lever in one direction engages the lifting clutch and moving it in the opposite direction engages the lowering clutch. When the work has been brought to the desired position, the lever is thrown to the central or neutral position; in this position neither clutch is engaged and the work is held stationary.

The trolley follows in or out on the jib as the workman moves the casting. The swinging jib also follows the movement of the casting. By this means it is an easy matter for the operator to swing any surface of the casting into contact with the wheel. The emery wheel stand is mounted at the front of the base and gives plenty of clearance in front and under the wheels. The arbor is made of steel and runs in long self-oiling bearings. A detachable rest is provided which is convenient for use with the lighter classes of work which are handled on this machine. The wheels are protected by steel guards. Two steel frames, constructed of channels, are

Fig. 1. Right-hand Side of Crane Grinder, showing Method of Operation

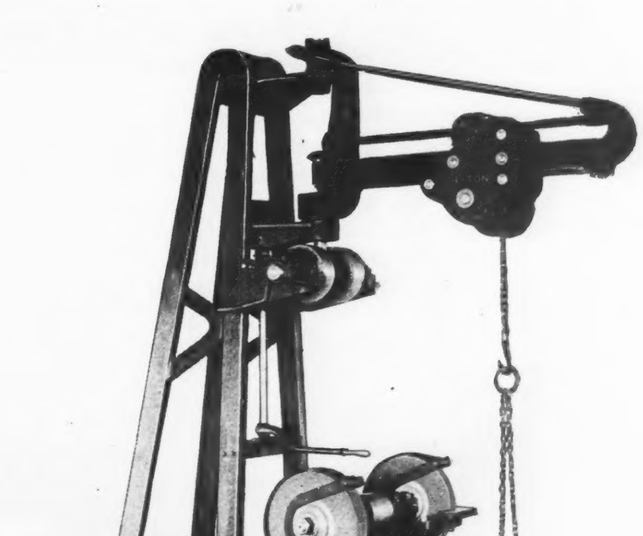


Fig. 2. Left-hand Side of Machine

mounted on the back part of the base and the brackets which support the swinging arm of the jib crane are fastened to these frames. The countershaft which runs in self-oiling bearings is placed at the back of the machine so that the belts are out of the operator's way.

SCRIVEN SPEED REGULATOR

The variable speed jackshaft shown in Figs. 1, 2 and 3, is manufactured by the S. & S. Variable Speed Gear Co., 50 Church St., New York City. This device consists of a pair of pulleys which may be expanded or contracted to give the required speed regulation. It is operated by a chain or handwheel, and when one pulley is expanded the other is contracted a corresponding amount or *vice versa.*

The construction of this regulator will be readily understood by referring to Fig. 3 which shows a view of one of the

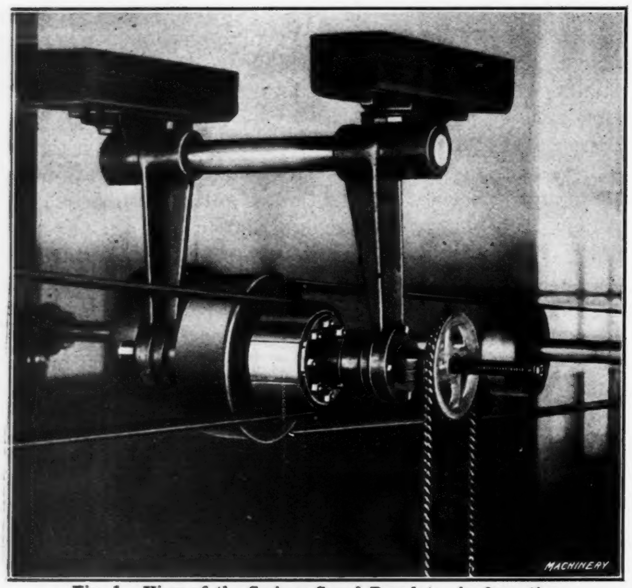


Fig. 1. View of the Scriven Speed Regulator in Operation

pulleys with the end plate removed. The two pulleys are bolted together and mounted on tubular shafts shrunk into end plates which form the outside of the built-up hub. The pinion shown in Fig. 3 is operated by the chain or handwheel previously referred to. This pinion meshes with gear teeth cut in the spokes of the pulleys which support the members of the expanding rims. These spokes are staggered so that they do not interfere with one another. One pulley is assembled right- and the other left-hand so that turning the pinion

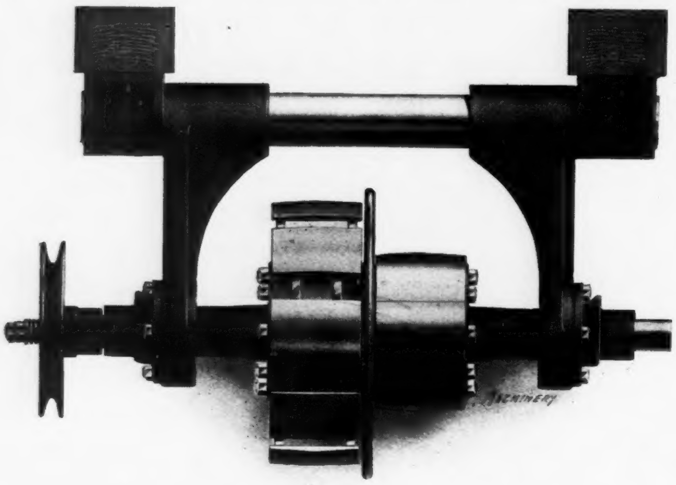


Fig. 2. The Scriven Variable Speed Jackshaft

expands one pulley and contracts the other. The spokes fit into slots milled in the plates which compose the hub of each pulley, and the arrangement is such that when the pulley is expanded to its largest diameter there is still two-thirds of the spoke supported by the hub.

When the operating wheel or chain is moved, a threaded sleeve communicates a longitudinal movement to an inner shaft which turns the tubular shaft. This shaft has spiral grooves of long pitch cut in a portion of its length which transmit a rotary movement to the pinion; this construction makes it impossible for the speed to alter through vibration. The load is carried by the two expansion pulleys and is balanced by the action of the pinion in expanding and contracting the pulleys. The running shaft is free to move back and forth to adjust itself to the load. In this way the tension is always kept equal, as any change made in the adjustment of the speed regulator causes one pulley to take up the length of belt that is given out by the other pulley. The running shaft swings to automatically adjust itself to the new condition.

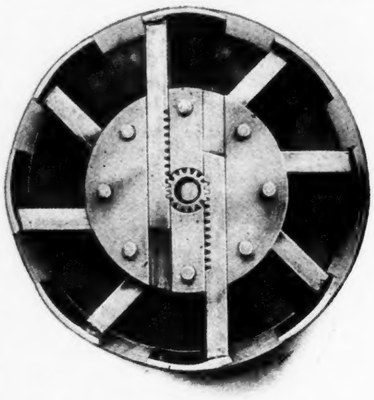
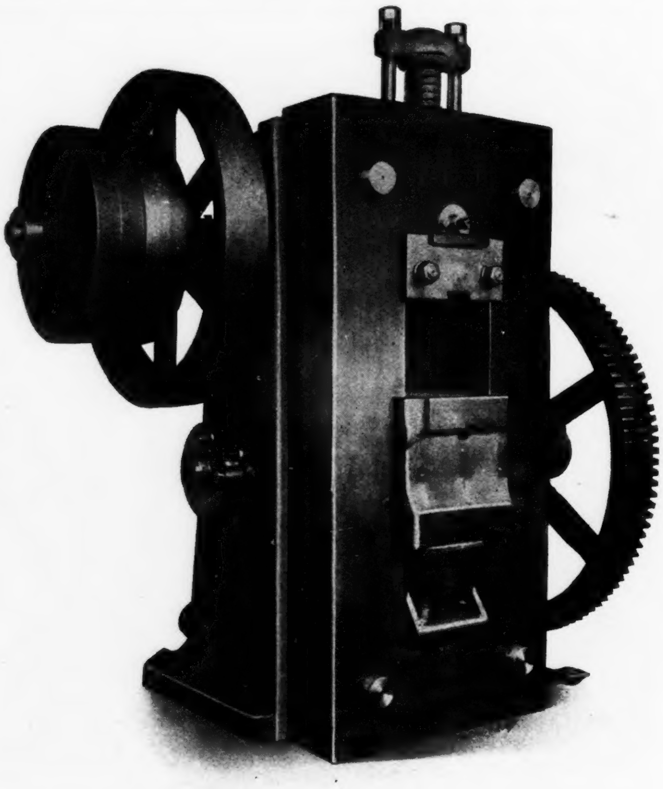


Fig. 3. View of Pulley with End Plate removed to show Mechanism

MAX AMS KNUCKLE JOINT PRESS

The illustration shows a heavy knuckle joint press which has recently been brought out by the Max Ams Machine Co., Mt. Vernon, N. Y. The application of the knuckle joint principle on this machine gives a slow powerful movement at the end of the stroke which makes presses of this type especially suitable for coining and swaging operations, where it is necessary for the metal to flow under pressure. The design of


Max Ams Knuckle Joint Press for Coining and Swaging Operations

this press has been worked out with the view of making it as compact as possible so that the minimum amount of floor space will be required. The frame which receives the pressure is a steel forging securely bolted to a cast-iron frame that carries the driving mechanism. The toggle links are steel castings and the pins and seats are of tool steel hardened and ground. They are placed below the table so that all lost motion is taken up by the weight of the mechanism. This arrangement also has the advantage of preventing oil from running on the dies and work. The table is guided by adjustable bearings.

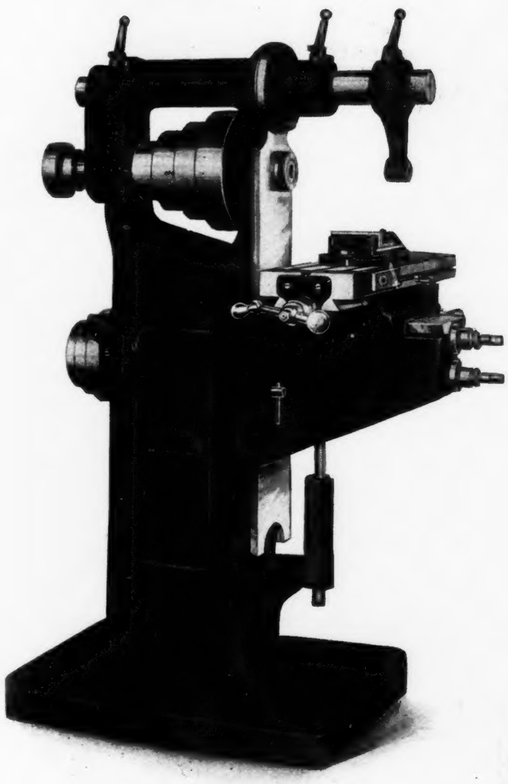
The adjustment for the dies to regulate the pressure is

obtained by a steel wedge which is adjusted by a screw. This screw is provided with a collar graduated to 0.001 inch which enables the operator to keep an accurate record of the setting of the dies. The clutch is of the sliding key type and is constructed in such a way that no backlash can occur.

This press will exert a pressure up to 600 tons. The width between the uprights is 14 inches, the largest die space 12 inches, the stroke 1¼ inch and the adjustment ⅜ inch. The flywheel is 45 inches in diameter by 6 inches face and weighs 1100 pounds. The tight and loose pulleys are 28 inches in diameter by 6 inches face and the ratio of the gearing is 1 to 8 1/3. The total height of the machine is 93 inches and the total weight 19,000 pounds.

ROCKFORD NO. 0 PLAIN MILLING MACHINE

The illustration shows a plain milling machine known as the No. 0 type which has been brought out by the Rockford Milling Machine Co., Rockford, Ill. This machine is provided with six belt-driven feed changes and the feed can be operated and reversed while the machine is in motion. The table has a working surface of 30 by 7½ inches and is fitted to the saddle with taper gibs for taking up wear. It has oil grooves on the sides and oil pockets at each end. The knee is extended at the top and has an exceptionally long bearing on the column of the machine. The spindle runs in bearings fitted with felt oil retainers. The bearings are adjusted from the rear end of the spindle by means of a nut. It will be seen that an overhanging arm is provided for heavy work. This arm is fitted with the Rockford Milling Machine Co.'s patented flanged support bolted to the column. This construction gives great stiffness, materially reducing vibration and effecting a corresponding increase in cutting capacity.



Rockford No. 0 Plain Milling Machine

Fig. 1. Keen Hardness Tester

Fig. 2. Detail of Level A

Fig. 3. Detail of the Ball Socket

KEEN IMPACT HARDNESS TESTER

The importance of determining the proper degrees of hardness in various metals for different uses is being generally recognized in almost every manufacturing establishment. Not so very long ago the hardness of metals was not considered of special importance except in the extreme conditions of hardness or softness. It is understood now, as it always has been, that hardness is simply relative, being the term applicable to all conditions varying from the softest talc to the hardest diamond. Copper and lead, as well as the best tool steel, each possess their peculiar degrees of hardness.

In manufacturing bearing metals, such as babbitt or bronze, it is necessary to produce compositions of suitable hardness for many different conditions of service. Copper, though a soft metal, presents considerable variation in hardness, depending on the impurities present or the physical condition produced by rolling and heat-treatment. The importance of recognizing and measuring variations in hardness must appeal to everyone who has had experience in the working of metals.

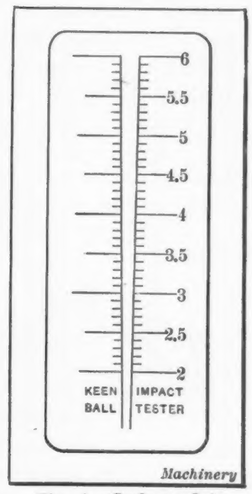


Fig. 4. Scale used to interpret Results

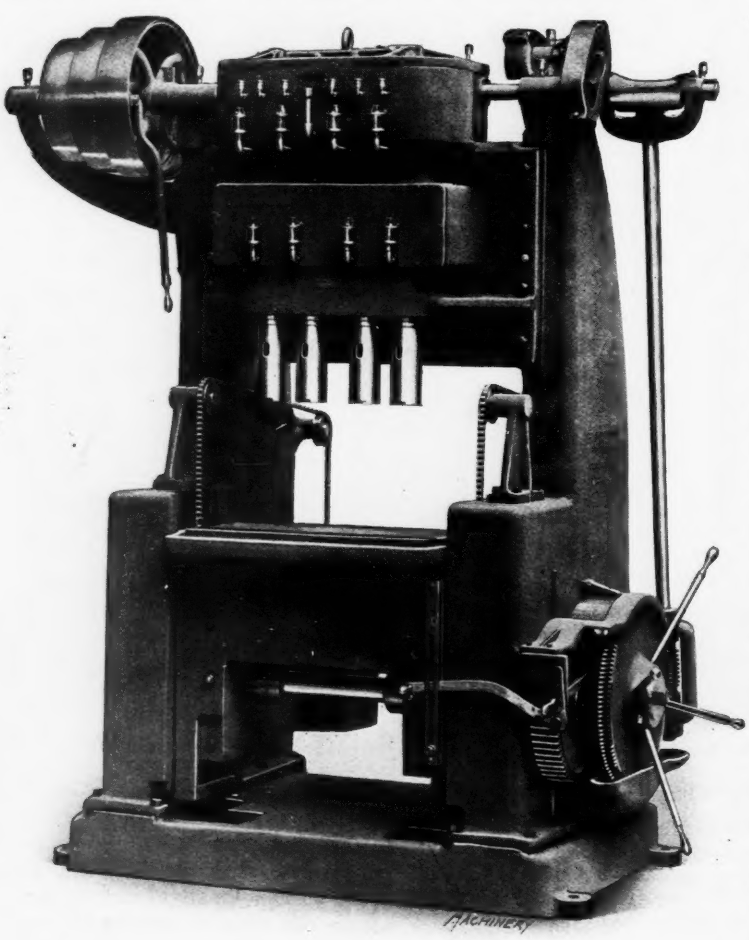
The steel industry offers a particularly appropriate field for a study of hardness and it is in this field that instruments were first devised for study. Many types of devices have been used, most important of which are the old file test, the Turner scratch sclerometer, Keep's drilling test, the Brinell ball method and Marten's cone modification, the Shore scleroscope and the Kryoff method of electro-magnetic balance. Of these instruments and methods the Brinell ball test and the Shore scleroscope seem to have met with the most favor.

A low priced and efficient instrument for studying metal hardness has recently been placed on the market by McKenna Bros. Brass Co., Pittsburg, Pa. This instrument, which embodies some of the features of the Brinell system and Shore system, enables anyone to make a scientific investigation of hardness of the metal which he is using in order to determine its suitability for the purpose. The instrument is called the impact ball tester and is shown in position for operation in Fig. 1. It makes practically the same test as the Brinell machine, but is much more convenient to use and more rapid in manipulation. It is portable, weighing only 6½ pounds, and may be carried anywhere and used intelligently by the "man on the job." The instrument is operated by raising the weight *C* until it touches *A*, the instrument being plumbed by means of the level in the top. When the weight *C* is released, it drops on *D*, giving a blow which is transmitted to the hardened ball *F*, causing a small circular dent to be made in the metal to be tested. The diameter of this indentation is determined by means of a celluloid scale which accompanies the instrument. The scale shows the hardness numeral directly opposite the point of tangency when laid over the dent and adjusted so that both lines are tangent to the circle. The degree of hardness, of course, varies inversely as the diameter of the indentation.

FOOTE-BURT CYLINDER BORING MACHINE

The four-spindle boring machine illustrated herewith is a product of the Foote-Burt Co., Cleveland, Ohio. This machine was especially designed for boring and reaming cylinders and can be used with equal success on cylinders cast singly, in pairs or *en bloc*. In operating machines of this type the work is held in a suitable box jig provided with removable jig plates equipped with the usual form of hardened and ground steel bushings. Bronze bushings on the spindles of the boring machine fit into these jig plate bushings after the boring tool has left them and provide support for the spindles while engaged in the boring operation. It will be evident that with a jig of this type bolted to the table of the machine and guiding the spindles, the entire machine is braced in such a way that there is practically no chance for deflection under cut. The use of worm and worm-gear drive with a final reduction through double pitch nickel steel spur gears, insures a steady drive under all conditions. The spindles are made of special high-carbon steel forgings and run in taper bearings provided with means of adjusting for wear. It will be seen from the illustration that the driving mechanism is entirely enclosed, and all of the gears run in oil.

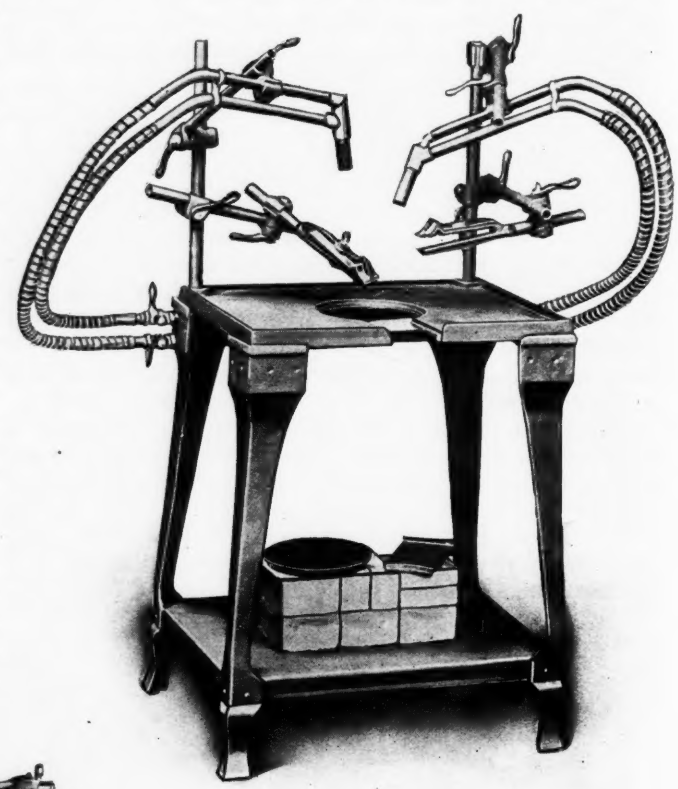
The feed is also through worm and worm-gears with the final drive through spur gears. An extremely accurate knockout is provided to disengage the power feed. Counterweights are attached to the table directly in line with the spindles and the table slides are so proportioned that the table does not feed out of the ways even at the highest point of its travel. A brake is provided to stop the spindles quickly at the end of a cut and prevent scoring the cylinders when the table is returned. The entire operating mechanism is simple and compact and arranged to insure the maximum output without requiring excessive effort on the part of the operator. These boring machines are built in several different styles to meet various requirements. The machine shown in the illustration is a four-spindle fixed-center boring machine. Machines of this type are built with two, three, four or six spindles to meet the requirements of different classes of work. In addition to the fixed-center type, machines are also built with the center distance adjustable with two, three and four spindles. The capacity of the machines is such that they can drive high-speed steel boring tools to the limit of their capacity.



Four-spindle Fixed-center Type of Foote-Burt Cylinder Boring Machine

IMPROVED BRAZING TABLE

The distinctive feature of the brazing table shown in the accompanying illustration is the method by which the work and the burners are supported. Referring to the illustration, it will be seen that two vertical supports are provided at the rear of the table and the burners and work holders are secured to these supports by universal clamps. The position of both the work and burner clamps may be adjusted vertically on the supports; any desired position along the horizontal bars may be obtained in a similar manner, and the clamps may be set at any desired angle by adjusting the clamp brackets. These clamp brackets are made in two parts which are held together by an adjusting screw, the joint being provided with teeth to afford a secure grip. The adjustments which are provided by these universal clamps make it possible to hold the work in any position over the table, and the burners can then be adjusted to apply the heat in this position. The work holders are so efficient that it is unnecessary to rivet many classes of work before brazing.


Improved Brazing Table with Universal Work and Burner Clamps

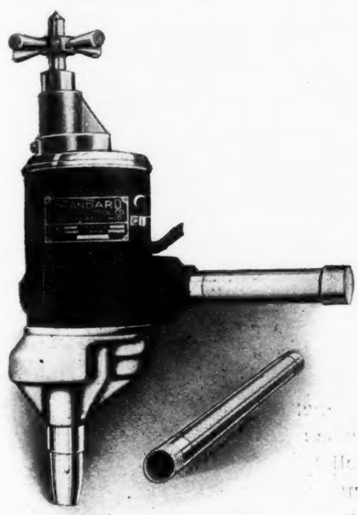
The brazing table is made of cast iron and is 18 by 24 inches in size. A removable center 7½ inches in diameter is provided and also a removable front section 3½ inches in width. The burners are made of wrought iron, which makes them particularly serviceable, and they are provided with ⅞-inch brass nozzles. Two horizontal pipes run along the back of the table. These pipes are connected with the air and gas mains, respectively, and it will be seen that connection is made with the burners from each end of these pipes by means of armored rubber hose. The gas consumption is 200 cubic feet per hour per burner, when the burners are working at their full capacity, and the air pressure required is ½ pound or more.

A useful shop forge or furnace of any desired shape may be made by building up a firebrick structure on the table, spaces being provided to admit the burners. Such a gas heated

furnace may be successfully used for forging, tool dressing, straightening bent axles and other classes of service. In addition, bearing metals may be melted off bearings, babbitt and solder pots quickly heated, and other classes of service of this kind handled in a convenient manner. This brazing table is a product of the Improved Appliance Co., 455 Kent Ave., Brooklyn, N. Y.

STANDARD 1 1-4 INCH PORTABLE ELECTRIC DRILLS

The Standard Electric Tool Co., Cincinnati, Ohio, has added two types of 1¼ inch portable electric drills to its line which have a capacity up to 1¼ inch in steel. One of these tools is of the universal type and may be operated on either alternating or direct current circuits; the other is intended for use on direct current only.



Standard Portable Electric Drill for either Alternating or Direct Current

The special features of these tools may be briefly outlined as follows: Ball bearings are used throughout; the motors are constructed to withstand the hard use to which tools of this kind are frequently subjected and still maintain their highest electrical efficiency; the motors are of the series type; all gears are of steel and generated in the Fellows gear shaper; the gears are casehardened, mounted on ball bearings and packed in grease; the tools are of very simple construction, being made up of five units that can be taken apart without disturbing any of the electrical connections. This is particularly convenient when it is necessary to dismantle a tool for cleaning or inspection.

BURKE BUSHING SPLITTING MACHINE

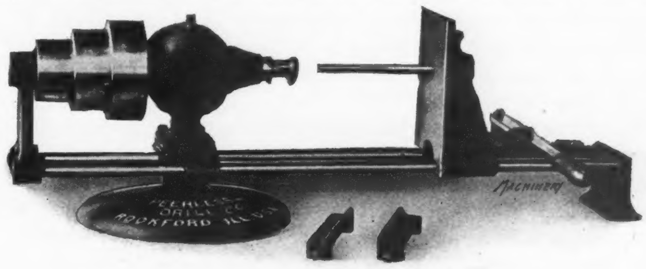
The two-spindle milling machine shown in the accompanying illustration is manufactured by the Burke Machine Tool

Burke Two-spindle Milling Machine adapted for splitting Bushings

Co., Conneaut, Ohio. The illustration shows the adaptation of this machine for splitting bushings up to six inches in length. For this purpose the machine has been equipped with the special table shown on which an air chuck is mounted. The work is held in this chuck and both sides of the bushing are split at the same time.

PEERLESS TAPPING AND THREADING MACHINE

The tapping machine shown in the accompanying illustration is a recent product of the Peerless Drill Co., Rockford, Ill. The design of this machine adapts it for practically all classes of tapping operations and also for threading long rods, pipes and tubing. The illustration shows the machine set up for a



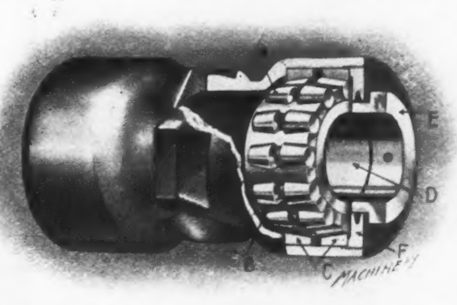
Peerless Tapping and Threading Machine

threading operation, the method of setting up the work and operating the machine being apparent. For tapping operations, the tap is mounted in the spindle of the machine in place of the die shown in the illustration.

This is a convenient machine for use in the manufacture of gas and electric fixtures. The nose of the spindle is 1¼ inch in diameter and the hole through the spindle ¾ inch in diameter. The chuck can be placed either on the spindle or on the vertical table of the machine as desired, to meet the requirements of different classes of work.

MAKUTCHAN ROLLER BEARING

The illustration shows a roller bearing which has been developed by the Makutchan Roller Bearing Co., 332 S. Michigan Ave., Chicago, Ill., for use on commercial motor vehicles. A casual glance at the design of this bearing might lead one to believe that it violated the principles governing the design of equipment of this kind. Such, however, is not the case for



Makutchan Roller Bearing for Commercial Motor Vehicles

the lines of contact between the rollers and the inner and outer races of the bearing correspond with the theoretical line of contact which a ball of large diameter would have in engagement with races of this width. The manufacturers claim that the efficiency with which the rollers of this bearing run in their races is equal to the efficiency with which the large balls referred to would run, and tests which they have conducted tend to show that the friction loss in the bearing is not greater than 0.25.

Referring to the illustration, the rollers are shown at *A*. *B* is a bronze separator which maintains the proper alignment of the rollers in the bearing. A pair of tapered cups which constitute the outer race are shown at *C* while the inner race is illustrated at *D*. The part *E* is known as the "shaft collar." This collar is a close fit on the shaft and is secured against the end of the bearing by means of a set-screw. It will be seen that an adjusting nut *F* is carried in the threaded end of the hanger. This nut regulates the adjustment of the bearing. It will readily be seen that moving the nut in or out tightens or loosens the tapered cups *C*. By this means, any wear which develops in the bearing can be compensated

for without the necessity of renewal. In use, the rollers are packed with a light grease and do not require attention more than once or twice a year. Bearings of this type have a capacity for carrying an amount of lateral thrust load equal to the radial load for which they are adapted.

STANDARD DOUBLE-ACTION SINGLE CAM PRESS

The Standard Machinery Co., 7 Beverly Pl., Providence, R. I., has brought out a double-action single cam press designed for working celluloid, rubber, and other pliable materials. Such materials work better under a heat up to about 600 degrees F., and the purpose of this press is to provide means of heating as well as working the celluloid or rubber that is being operated upon.

The construction and principle of operation may be briefly outlined as follows: The blanking ram is actuated by two connecting-rods which straddle the crankshaft and operate the machine on a one-inch stroke. The drawing and forming plunger passes up and down through a bronze lining inside the blanking ram and is provided with a special separate adjustment. The top of this ram is made in the form of a yoke and is supported by a spring adjustment connected to the upper part of the frame of the press. It is actuated by a single split cam which is made of hardened and ground tool steel; the design of this cam will be readily understood by referring to Fig. 3. This cam is made in halves and keyed and screwed on the center of the crankshaft midway between the upper boxes of the press. The cutting stroke of the blanking ram is 1 inch, but the total drawing stroke afforded to the inner ram by the cam is 1¾ inch and is made as follows: When the press is started, both the blanking ram and drawing ram start on the downward stroke. The drawing ram travels down 1¼ inch and it then dwells during one-fourth revolution, after which it draws the remaining part of the stroke, which is ½ inch.

A special die-holder is set on the bolster plate of the press, and by referring to Fig. 2, two holes can be seen in this die-holder which are provided for the purpose of inserting electric terminals. In the punch holder of the press, a recess for two more electric terminals is provided. These terminals are set at right angles to those in the die-holder, one being at the front

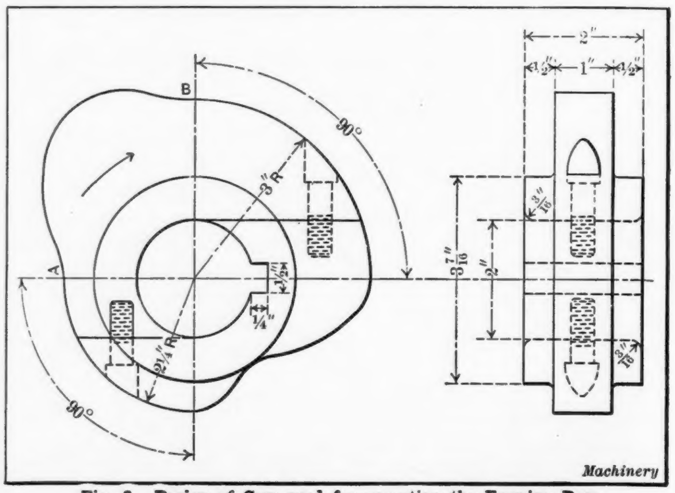


Fig. 3. Design of Cam used for operating the Forming Ram

and the other at the rear. These electric terminals provide for heating the punch and die up to a temperature of 500 degrees F.

The celluloid or hard rubber stock is fed through the roll feed shown in Fig. 1, the stock coming in from the rear of the press. The center of the roll feed frame is at a distance of 8 inches from the center of the ram and is entirely separate from the die holder or punch holder, thus enabling the temperature to be kept practically normal at all times. When the stock has passed through the feed rolls it is still cold, and when the press is tripped, the blanking dies cut the disk or disks from the sheet. The drawing ram then comes down and draws or forms these disks into the required shape. The object of allowing a dwell after the forming punch has traveled 1¼ inch of its stroke is due to the fact that the material is very thick. This allows the impression to be made gradually, which has the effect of making the design more distinct.

In addition to building the machine with a roll feed, a design is being developed to use a dial feed for secondary operations. The principal dimensions of the machine are as follows: Over-all height, 6 feet; floor space occupied, 24 by 30 inches; distance between uprights, 14 inches; size of flywheel, 27 inches diameter by 4½ inches face; weight of flywheel, 300 pounds; total weight of machine, 1600 pounds.

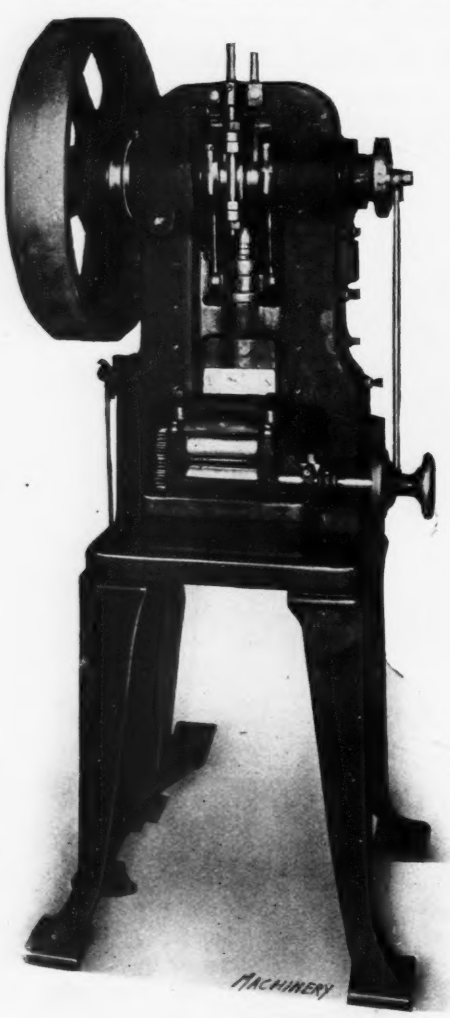


Fig. 1. Rear View of Press showing Roll Feed Mechanism

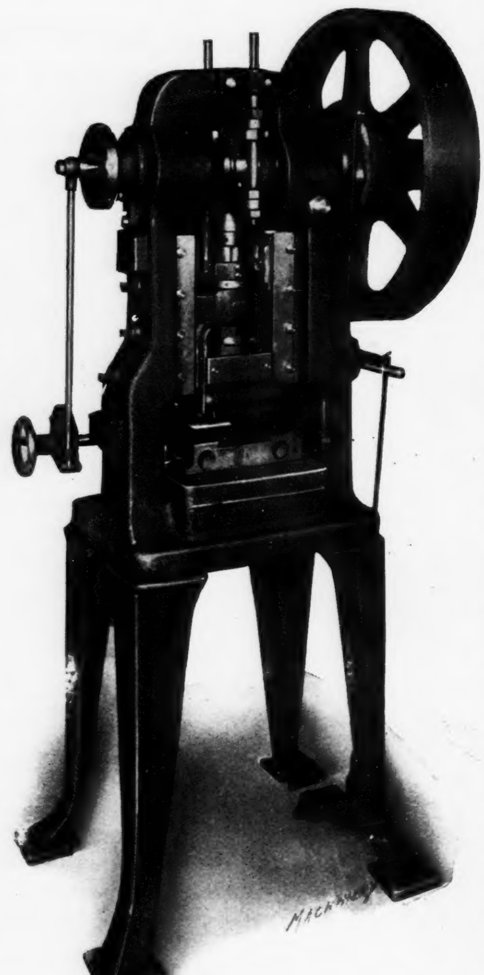


Fig. 2. Front View of Standard Press showing Electrically Heated Die Holder

LUFKIN TAPE WITH INSTANTANEOUS READING

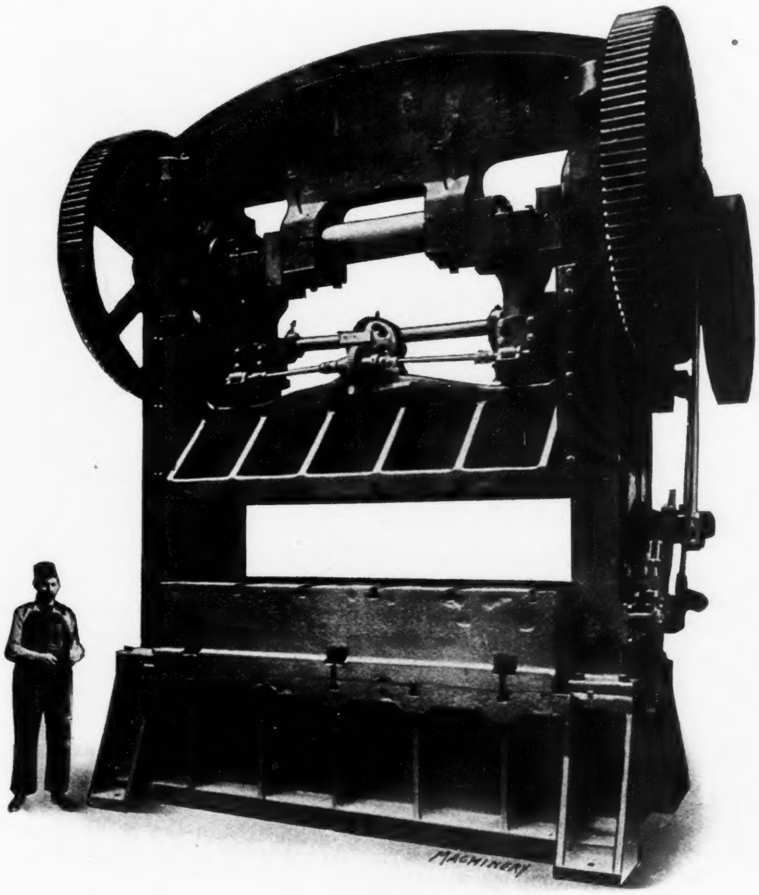
For the benefit of those readers not familiar with the meaning of the term "metallic" as applied to measuring tapes, it should be stated that this name is used to designate that class of woven tapes which has metallic strands interwoven with the linen threads. It does not mean that the tape is made of metal of any kind, as might be inferred, and metallic tapes must not be confcunded with steel tapes.

The Lufkin Rule Co., Saginaw, Mich., has just placed a metallic tape upon the market which has what is known as the

"instantaneous readings" method of graduation. This consists of placing small figures beside each inch mark on the tape which indicate the whole number of feet in the measurement. This makes it unnecessary to refer back to the last foot mark when taking readings and reduces the possibility of making an error. This method of graduation has been used by the Lufkin Rule Co. on the steel tapes of its manufacture, but has only recently been used on metallic tapes.

BLISS DOUBLE CRANK PRESS

Large power presses are now finding wide application in the production of sheet metal articles which were formerly made from castings and machine finished. The illustration shows a double crank press equipped with a special automatic stop feature which has recently been brought out by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is 19 feet high, weighs 190,000 pounds, exerts a working pressure up to 750 tons and is one of the largest presses which has been brought out by this company. Owing to the extreme strain to which the gearing is subjected, the entire train of gears are made of steel castings machine cut from solid metal. The ratio of the gearing is 38 to 1. The crankshaft which operates the slide has a stroke of 16 inches and is made from 50 point carbon open-hearth steel. The crankshaft is twin driven to avoid torsional strain during the operation of the press. The driving pinion on the intermediate shaft which imparts motion to the main gears is placed centrally on the intermediate shaft to eliminate the tendency toward torsional strains in this shaft.



Bliss Double Crank Press capable of exerting Pressure up to 750 Tons

The slide is adjusted by an independent electric motor fitted with a jaw clutch for starting and stopping. The motor is placed on the top of the slide and operates through universal joint connections to the multiple thread worms on the main connections. Both connections are adjusted simultaneously, alignment with each other. The counterbalance of the slide is effected by counterweights placed in the main driving gears. The distance from the bed to the lower face of the slide, stroke and adjustment up, is 64 inches, adapting the press for dies of considerable height; when shallow dies are to be operated, bridge bolsters are used. The machine is controlled by a hand-actuated powerful friction clutch of the double grip type. The clutch is arranged with a device by means of which the press is automatically stopped on the top center and which also permits of starting and stopping the moving parts at any point of the stroke independent of the automatic stop, giving the combined advantages of a positive automatic stop on the top center, and absolute control over the moving parts at any point of the stroke. Control of the device which, in turn, controls the friction clutch is by means of a spring handle which is attached to the shifter handle, the spring handle operating on a pin clutch. The pin clutch being operated direct from the shifter handle allows the operator to start the moving parts at any part of the stroke independent of the automatic feature for stopping the press on the top center. The pin clutch can, by a small lock attached to the shifter handle, be locked so that the press may be run continuously.

The automatic stop device is located on the lower part of the right-hand upright and is actuated from the crankshaft by means of the connecting rod, crank disk, rack and pinion. The automatic stop feature operates on the up-stroke of the crankshaft, when the pinion engages with the pin clutch which is connected to the rocker shaft to which are keyed the levers for operating the friction clutch. Another advantage in connection with this special feature of the press is that the press cannot be set in motion by any accidental pressure against the shifter arm, as it is first necessary to operate the spring handle before the press can be set in motion. The bearings of the back shafts, friction clutch and loose pulley are bronze bushed and the bushings have babbitt with graphite cast in them to aid lubrication. To avoid possible damage to the press by excessive pressure, the flywheel is arranged with a safety coupling.

Fig. 1. Smallest Size of Lennox Throatless Shear

LENNOX THROATLESS SHEAR

The accompanying illustrations show a new type of rotary metal shear designed along entirely new lines, which is a product of the Lennox Throatless Shear Co., Marshalltown, Iowa. The construction of this machine has been worked out to meet the demand for a shear that would cut sheets of metal of large size and irregular shapes. The main head of the machine is built with a helical throat which makes it possible for a sheet to be split and in or out curves cut to a very small radii.

The knives are designed to allow the cuts to be made without binding on the knives, causing chipping. The mechanical operation of this shear is such that it eliminates all unnecessary friction. As it is impossible to keep two knives of exactly the same diameter, it would be necessary to have a compensating drive to prevent one shaft from traveling faster than the other and causing a continuous slipping of the shears which would reduce their efficiency. To avoid this difficulty, only one shaft of the Lennox throatless shear is driven, and

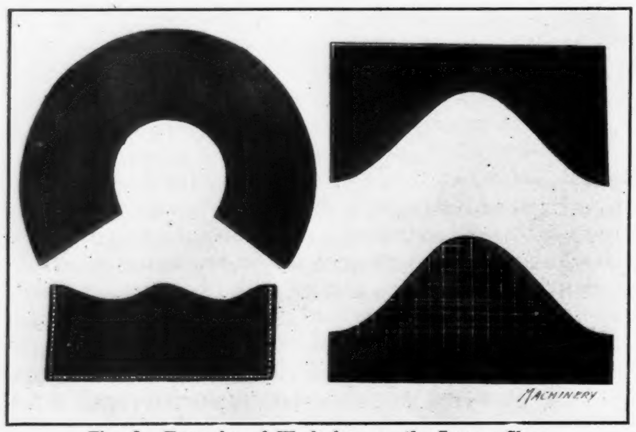


Fig. 2. Examples of Work done on the Lennox Shear

the manufacturers state that a saving of at least 50 per cent of the power requirements of the machine is effected in this way.

The main head of the machine is a steel casting and all other parts are of ample strength to withstand severe service. The machines are equipped with either belt or motor drive. When motor drive is used, a friction clutch gear is furnished which will allow the motor to run continuously and the shear

Fig. 3. Largest Size of Lennox Throatless Shear

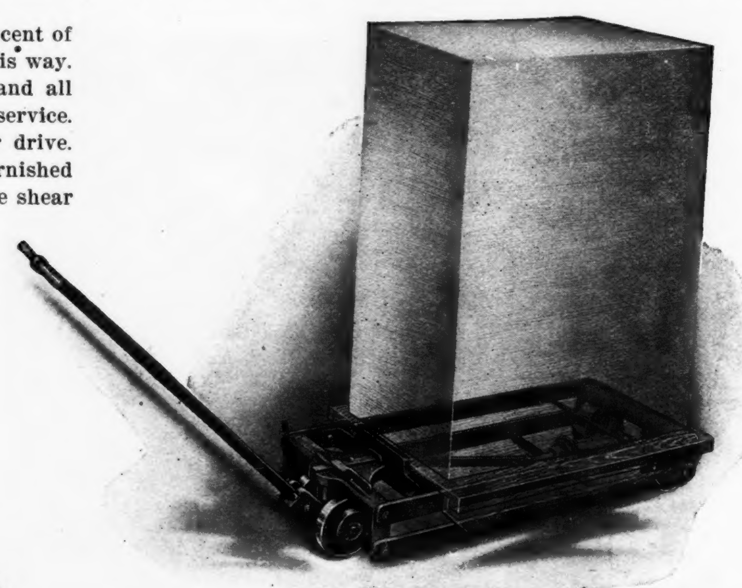
to be started and stopped instantly at the will of the operator. The design is of unusual simplicity and the machines occupy a very small amount of space.

The different sized shears of this line will cut to radii from $2\frac{1}{2}$ inches to 10 inches, according to the size of the shear, and they will handle work from No. 30 gage up to $\frac{1}{2}$ inch in thickness. Fig. 2 gives a good idea of the irregular cutting that can be done on the Lennox throatless shear. This illustration shows a dome sheet shearing, a square elbow pattern, and the two parts of a plate which have been sheared along the contour of a conic section.

NATIONAL ELEVATING TRUCK

To any manufacturer who has given the subject brief consideration, the increased efficiency attained through the use of elevating trucks and wooden skids for moving work through the factory—as compared with the ordinary form of truck—will be readily apparent. In using trucks of this kind, the work is placed upon a skid which is raised from the floor by side pieces. In order to put the skid and its load on the truck, it is merely necessary to back the latter underneath the skid; the truck is then elevated to enable the skid and its load to be carried to the position in the factory where it is required. The use of such a method effects a saving in several directions. In the first place, the number of expensive trucks which are required is greatly reduced, as it is not necessary to leave trucks idle in the factory with material stored upon them or to have the trucks standing beside a machine while a given operation is being performed upon the material with which they are loaded. For such conditions, the cheap wooden skid is quite as useful as an expensive truck and it is only necessary for a factory to buy a sufficient number of elevating trucks to look after moving the skids about the factory.

The accompanying illustration shows the Chapman elevating truck which has recently been brought out by the



National Elevating Truck with Check to prevent Load from dropping suddenly

National Scale Co., Chicopee Falls, Mass. This truck is lifted by means of the handle which is used to pull it. When the handle is raised to a vertical position, the truck is dropped to its lowest position and can then be easily backed under the skid. In order to pull the truck, the handle is naturally drawn forward into an inclined position and in so doing the truck is raised. The most important feature in the design of the elevating mechanism of this truck lies in the provision of a plunger check which prevents the load from being suddenly dropped onto the floor when the handle is released. The benefit of this design is particularly apparent where heavy loads are being handled. It is quite possible to handle loads as great as $1\frac{1}{2}$ ton on trucks of this type, and when such loads are allowed to drop suddenly upon the floor from a height of $1\frac{1}{2}$ inch, it will be found that considerable damage can be done to the building. In addition, the provision of this check acts as a safeguard to the operator of the truck. As it is impossible for the load to drop suddenly and jerk the handle forward with considerable violence, the danger of the operator being struck by the handle is eliminated.

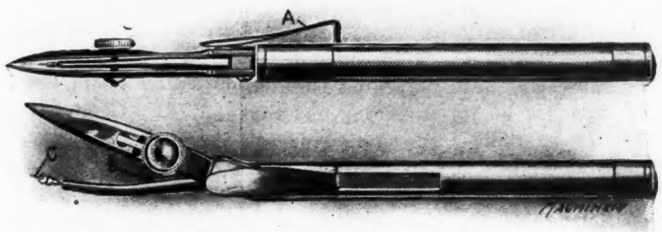
K. & E. FOUNTAIN DRAWING PEN

It is generally recognized that a large amount of the time required to ink in a drawing or make a tracing of a pencil drawing is spent in filling the drafting pen. Furthermore, difficulty is experienced in keeping the T-square and triangle in place while the draftsman is refilling his pen. Several

efforts have been made to overcome these difficulties by means of a fountain pen, but trouble has been experienced in getting India ink to flow properly in pens of this type. This trouble has been overcome by the Smith fountain drawing pen which has recently been placed upon the market by the Keuffel & Esser Co., Hoboken, N. J.

This new draftsman's pen is made of steel and German silver and the ink is held in a rubber reservoir inside the handle. The ink is delivered to the pen from this reservoir through a delivery tube which extends down between the blades of the pen as shown in the accompanying illustration. When the supply of ink becomes exhausted, the draftsman merely presses the lever *A*; this compresses the reservoir and forces ink down to the pen through the delivery tube *B*. It is not necessary to stop work to refill the pen and after a little practice the draftsman will be able to replenish the supply of ink while he is ruling a line.

In order to fill the reservoir, the pen is swung to one side as shown in the lower illustration and the wire *C* is then withdrawn from the delivery tube. The lever *A* is next pushed down to expel the air from the reservoir and the delivery tube



K. & E. Drawing Pen in Working Position and with Pen swung to One Side

is then dipped into the ink bottle. The lever *A* is now slowly released and this allows the ink to be drawn up into the reservoir. It is then merely necessary to replace the wire in the delivery tube—taking care not to entirely close up the end—and then swing the pen back into position. The end of this wire which passes into the tube is enlarged, and if any difficulty is experienced through the ink becoming clogged in the tube, the trouble is easily remedied by withdrawing the wire. The pen itself is provided with a quick-opening device to facilitate cleaning.

VEEDER COUNTERS

The illustrations show a new line of counters which has recently been brought out by the Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. There are two styles, termed, respectively, "setback" and "locked wheel" counters.

Fig. 1 shows the four-wheel "setback" counter suitable for use in counting separate lots of work on punch presses, printing presses, looms, stamping machines, etc. When the lot is finished the counter can be turned forward until all of the figures are at zero, by one turn of the knob provided for this purpose at the left-hand end of the counter. The resetting

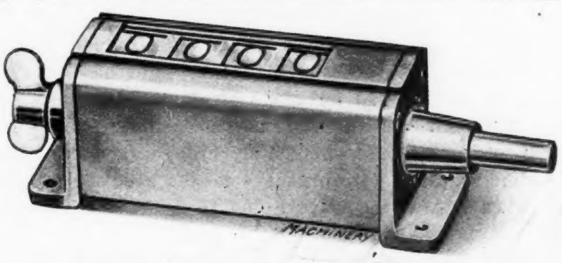


Fig. 1. Veeder Four-wheel Setback Counter

shaft picks up the number wheels from any position and carries them forward to zero, without the possibility of interference.

In the design of these new Veeder counters, special attention has been given to making instruments which will operate with the greatest ease; each wheel turns upon a comparatively small shaft and the pinions which transfer the motion from one wheel to the other, also turn upon small shafts. The wheels and pinions are so arranged that there is no frictional contact at their peripheries, except where the pinions engage the wheels, so that they turn with the utmost freedom. The counter is built up of units, each unit consisting of a short section or shell, which carries a pinion and entirely encloses the number wheel, with the exception of an opening through which the figures are read. This enables counters to be assembled with as many number wheels as may be desired within certain limits. The usual number of wheels supplied is four, but the counter may be made up with only two, or in special cases, with six or even eight sections. The greater the number of wheels, the greater is the wear and strain on the first transmitting pinion, so that a large number of wheels should not be employed where the counter is operated at a comparatively high speed. The unit shells which carry the wheels are held together between two end plates by means

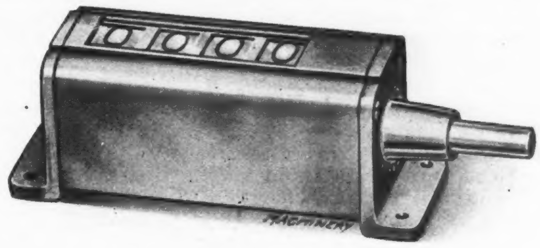


Fig. 2. Veeder Locked Wheel Counter

of four screws, and are usually covered by a drawn brass case which holds the glass window through which the figures may be read. In this complete form the counters are dust-proof and may be made waterproof by the application of suitable cement around the glass.

The "locked wheel" counter shown in Fig. 2 is similar to the "setback" counter except that its transfer pinions are solid and the number wheels are not provided with cams and pawls for setting them to zero. The number wheels are locked in all positions and cannot be moved, except through the mechanism provided for driving the right-hand ring. This type of counter is specially useful where work is paid for by the piece, as it may be connected to the machine in such a way that the figures cannot be moved except by running the machine.

NEW MACHINERY AND TOOLS NOTES

Precision Level: G. S. Crosby, 46 Lexington Ave., Brooklyn, N. Y. This level is made in two sizes, 5 and 8 inches. It is a one-minute level and is only intended for precision work.

Shop Goggles: Julius King Optical Co., 10 Maiden Lane, New York City. Shop goggles to protect the eyes of workmen engaged in operating grinding machines and similar classes of work.

Steel Shelving: Standard Steel Shelving Co., 149 Fremont St., Boston, Mass. Steel shelving constructed on the multiple-unit sectional system and adapted for stock racks, storeroom shelves, and similar purposes in manufacturing plants.

Metal-cutting Saws: E. C. Atkins & Co., Indianapolis, Ind. Two types of metal-cutting saws. The first is a hand saw made with either an adjustable or stationary handle, and a blade 18 inches in length. The second is an extension-frame hacksaw.

Direct-current Ammeters and Voltmeters: Weston Electrical Instrument Co., Newark, N. J. Four types of electrical indicating instruments which comprise a portable voltmeter, two forms of switchboard ammeters, and a battery testing voltmeter.

Boiler Plate Punching Machine: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A 48-inch open gap machine designed for punching out 6¾- by 12½-inch manholes in 1½-inch boiler plate. The machine was built for the Dillon Steam Boiler Works, Fitchburg, Mass.

Motor-driven Grinding Machine: Ransom Mfg. Co., Oshkosh, Wis. A grinder especially adapted for use on heavy steel castings in the foundry. The motor is mounted at the center of the machine and the armature shaft is extended at either end to carry the grinding wheels.

Autogenous Welding Outfit: George C. Schemmel, Wapakoneta, Ohio. A self-contained oxy-acetylene outfit for welding and cutting. The arrangement of the gas generators and other parts of the equipment has been worked out with the view of making the outfit as compact as possible.

Centering Device: Carroll-Jamieson Machine Tool Co., Batavia, Ohio. This device fits the lathe-spindle taper. The driving chuck is self-centering and the tailstock fixture may be readily adapted for different diameters of shafting. The

tool is made in two sizes for maximum diameters of 1¾ and 3 inches.

Punch Press Safe Guard: Hardware Supply Co., Grand Rapids, Mich. A punch press safeguard fastened to the machine by means of a bolster bolt at the right-hand side. The guard is operated by a chain connected to the treadle and throws the operator's hands out of the "danger zone" before the ram can descend.

Die-sinking Machine: Melling-Northrup Co., Jackson, Mich. This tool combines the cherrying and profiling mechanisms in a single machine, and oscillating cutters are used in place of the usual revolving cutters in the cherrying device. The chief claim made for the machine is the economy which it effects in die-sinking operations.

Peening Machine: William Gibbs, Brantford, Canada. Machine for peening the steel disks used on seeding drills. Its essential parts consist of two plates provided with a series of rings filled with hardened balls. These plates are driven in opposite directions, and form the disk mounted between them to the required shape.

Rivet Heater: Improved Appliance Co., 455 Kent Ave., Brooklyn, N. Y. A rivet heater made in two sizes having a capacity for heating rivets ¾ by 3 inches at the rate of 100 per hour and 180 per hour, respectively. The smaller size will take rivets up to 4 inches in length; and the larger size takes rivets up to 6 inches in length.

Disk Grinder: Diamond Machine Co., Providence, R. I. A grinding machine designed for the use of either disk wheels or ring-wheel chucks. The spindle has cast-iron split bearings tongued and grooved for adjustment, and the thrust is taken on the right-hand side of the column where hardened and ground tool-steel collars are provided.

Knurling Tool: C. A. Herman, Woonsocket, R. I. A tool designed to knurl work up to the last 1/32 inch in a speed lathe, bench lathe or drilling machine. The handles are slotted to admit the knurls, and a slotted tongue into which a pin at the end of one handle fits provides for adjusting the tool for different diameters of work.

Keyseat Milling Machine: Premier Machinery Co., Milwaukee, Wis. A small keyseat miller, the spindle of which is driven by an internal expanding friction clutch. The machine has power vertical and longitudinal feed. The table has a longitudinal movement of 6 inches. The machine may be removed from the base and clamped on a shaft for cutting a keyway by hand.

Universal Grinder: Cincinnati Grinder Co., Cincinnati, Ohio. A 16 by 72 inch universal grinding machine built for manufacturing work. The machine swings 16 inches over the table and takes work up to 72 inches between centers. The wheel spindle carries a wheel 14 inches in diameter by 1½ inch face, and runs in phosphor-bronze boxes provided with means of compensating for wear.

Constant-speed Milling Machine: Kearney & Trecker Co., Milwaukee, Wis. A milling machine with constant-speed motor-drive, especially designed for heavy duty. The machine is equipped with means for automatic lubrication of the gears, bearings and milling cutters. It is driven by a five-horsepower Westinghouse electric motor mounted on an adjustable bracket, power being transmitted through reduction gears mounted inside the machine.

Armor-plate Planing Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This is a double-action machine with a toolpost that carries two steel relief tool aprons on which the tools are mounted to cut on both the forward and return strokes. Each apron is mounted on a swivel saddle to relieve the side tool pressure on either return stroke. The main saddle carrying the tool-post is counterweighted and provided with power feed and fast-reversing traverse.

Chip Separator: W. M. McKenzie, Dorchester Center, Mass. A machine designed for separating screw machine product from chips, after the oil has been extracted. It will separate parts as small as 0.07 inch in diameter by 3/16 inch in length. In operation, the workman simply dumps the oil-extractor pan into a receiving hopper, from which the product and chips pass down a chute. The chips are blown into a receiving box while the finished parts are delivered into a receiver.

Offset Boring Head and Drill Chuck: J. T. Flynn Mfg. Co., 1181 Porter St., Detroit, Mich. A change in the No. 10 chuck of this company's manufacture which consists of an improvement in the design of the adjusting screw. The screw is now made in two pieces, one having a square head which fits into a corresponding socket in the other part. Each part of the screw has a groove cut in it into which is fitted a collar. These collars fit into grooves in the cross block and insure having the jaws properly located.

Spring Winding Machine: Sleeper & Hartley, 98 Beacon St., Worcester, Mass. A manufacturing machine which combines a wide wire range with a capacity for a large variety of spring forms. In operation, the wire is taken from a coil and fed into the machine where the spring is wound and cut off automatically. The wire range is from No. 20 to No. 8. Wire from No. 20 to No. 14 may be wound into springs of from 1 to 22 coils, while from No. 14 to No. 8 wire can be wound into springs having from 1 to 13 coils per inch.

Instrument for Testing the Ways of Machines: C. H. Norton, Worcester, Mass. This device was developed by Mr. Norton to enable the operation of testing the straightness and parallelism of the ways of machines to be performed with greater rapidity and accuracy than was possible with former methods. The device consists of an aluminum base resting on three points of support. A vertical mast about 10 feet in height is supported by this base and carries two indicators, which move in planes at right angles to each other. The design of the instrument is such that any error is magnified from 400 to 500 times.

Boring and Turning Mill: Niles Tool Works, Hamilton, Ohio. This machine is said to be one of the largest boring and turning mills which has ever been constructed. It was built for the Philadelphia plant of the William Cramp Ship & Engine Building Co. Aside from its unusual size, the most distinctive feature of the machine is the reach arm which is 31 feet in length. This long arm is necessary for reaching the center of the table when the housings are set back. A boring head traverses the entire length of the arm and any piece of work from 10 inches to 29 feet in diameter can be handled by the machine.

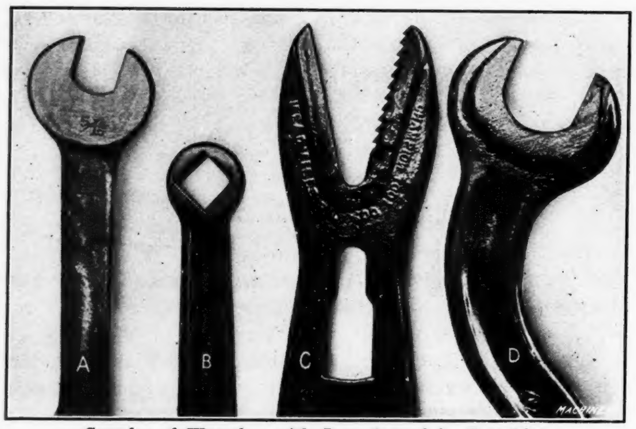
* * *

BROACHING WRENCHES

The illustration shows four types of wrenches on which the J. N. Lapointe Co., New London, Conn., has accumulated some interesting data regarding possible speeds of production when broached on its broaching machine.

The first example *A* shows one end of a double open wrench for a 5/16-inch U. S. standard nut, the opening for which is 19/32-inch wide. Special jigs were made for holding all the wrenches shown, taking three or four, or even six at a time. Thus 200 to 300 wrenches per hour could be broached. It was found that a broaching tool holds its size on this work much longer than any other form of tool suitable for doing the same work.

The box wrench shown at *B* cannot be done at as high a rate per hour as the open-end wrenches, of course, because



Samples of Wrenches with Jaws formed by Broaching

of the smallness of the broach. The production rate on this piece, in which the opening is ½ inch square, was 100 per hour.

The alligator wrench shown at *C* has a vee-shaped opening, one side of which is smooth, the other side having serrations or teeth standing at an angle of about 80 degrees with the side. Both sides of the vee were broached at one operation. The saving of time effected by broaching as compared with the time required with ordinary means used for finishing alligator wrench jaws is so great as to make a comparison of the figures almost ridiculous.

The wrench shown at *D* is an open-end S-wrench, the end shown for a ½-inch nut, having an opening ⅞ inch wide. As stated previously, the production rate for the open-end type of wrenches was found to be from 200 to 300 an hour, depending on the number of wrenches operated on at once. The number operated on at once was as high as six at a time with the smaller sizes.

* * *

The seven most important exporting ports of the United States in the order of the value of the exports shipped from each, are New York, Galveston, New Orleans, Baltimore, Philadelphia, Boston and San Francisco.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-sixth annual convention of the American Railway Master Mechanics' Association and the forty-seventh annual convention of the Master Car Builders' Association were held at Atlantic City, June 11 to 18, inclusive. The Master Mechanics' convention was held June 11, 12 and 13 and the Master Car Builders' convention, June 16, 17 and 18 on Young's New Pier. The technical program of the American Railway Master Mechanics' Association included the following papers and discussions:

June 11—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Specifications for Cast-steel Locomotive Frames". Individual Papers: "Maintenance of Electrical Equipment," by C. H. Quereau; "Engine Testing Plant," by Prof. E. C. Schmidt.

June 12—Discussion of reports on: "Main and Side Rods"; "Safety Appliances"; "Design, Construction and Maintenance of Locomotive Boilers"; "Steel Tires"; "Minimum Requirements for Headlights"; "Standardization of Tinware"; "Superheater Locomotives"; "Specifications for Materials Used in Locomotive Construction." Individual Paper: "Three-cylinder Locomotives," by J. Snowden Bell.

June 13—Discussion of reports on: "Use of Special Alloys and Heat-treated Steel in Locomotive Construction"; "Smoke Prevention"; "Engine Tender Wheels." Individual Paper: "Tests of Superheater Locomotives," by Dean C. H. Benjamin.

The following officers were elected for the American Railway Master Mechanics' Association:

President, D. R. MacBain, L. S. & M. S. Ry.
First vice-president, F. F. Gaines, Central of Georgia Ry.
Second vice-president, E. W. Pratt, C. & N. W. Ry.
Third vice-president, Wm. Schalfge, Erie R. R.
Treasurer, Angus Sinclair, *Railway and Locomotive Engineering*, New York City.
Executive Committee: W. J. Tollerton, Rock Island Lines; J. F. DeVoy, C. M. & St. P. Ry.; J. R. Wallis, P. R. R.; F. H. Clark, B. & O. R. R.

The program of the Master Car Builders' convention was as follows:

June 16—Discussion of reports on: "Revision of Standards and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe and Brake Beam Equipment"; "Coupler and Draft Equipment"; "Car Wheels."

June 17—Discussion of reports on: "Safety Appliances"; "Rules for Loading Materials"; "Overhead Inspection"; "Car Trucks"; "Train Lighting and Equipment"; "Train Pipe and Connection for Steam Heat"; "Tank Cars"; "Specifications for Tests of Steel Truck Sides and Bolsters for Cars of 80,000, 100,000 and 150,000 Pounds Capacity." Topical Discussion: "Retirement from Interchange Service of Cars of 40,000 and 50,000 Pounds Capacity"; Discussion of reports on: "Capacity Marking of Cars"; "Lettering Cars."

June 18—Discussion of reports on: "Damage to Freight by Unloading Machines"; "Air-brake Hose Specifications"; "Revision of Present Specifications Car Construction."

The following officers were elected for the Master Car Builders' Association:

President, M. K. Barnum, I. C. R. R.
First vice-president, D. F. Crawford, P. L. W. of P.
Second vice-president, D. R. MacBain, L. S. & M. S. Ry.
Third vice-president, R. W. Burnett, C. P. Ry.
Treasurer, John S. Lentz, L. V. R. R.
Executive Committee: C. E. Fuller, U. P. Ry.; T. M. Ramsdell, C. & A. R. R.; C. F. Giles, L. & N. R. R.

The annual exhibition of railway car and locomotive parts supplies, etc., held on the pier simultaneously with the conventions under the auspices of the Railway Manufacturers' Supply Association, was larger than ever before. The exhibit space had been increased by nearly 5000 square feet, making a total of over 88,000 square feet. The exhibit included a number of new and interesting machine tools, under demonstration. Among the manufacturers exhibiting were the following concerns:

American Pulley Co., Philadelphia, Pa. Pressed steel pulleys for lineshafting, etc.

American Tool Works Co., Cincinnati, Ohio. Motor-driven machine tools, comprising 30-inch lathe, 16-inch toolroom lathe, 6-foot radial drill, 3-foot radial drill and 24-inch back geared crank shaper.

Baker Bros., Toledo, Ohio. Heavy-duty high-speed drilling machine equipped with ball bearing gear box and alloy heat-treated steel gears.

Baush Machine Tool Co., Springfield, Mass. 6-foot radial drill and automatic staybolt drilling machine.

Besly & Co., Charles H., Chicago, Ill. Besly motor-driven disk grinder and Besly patternmaker's disk grinder and shaper.

Best, W. N., New York City. Burners using oil and tar for locomotive, marine and stationary boilers, and other liquid fuels for furnaces, etc.

Boker & Co., Hermann, New York City. Tool steels.

Brubaker & Bros., W. L., Millersburg, Pa. Taps, reamers, dies, end mills, etc.

Bullard Machine Tool Co., Bridgeport, Conn. 36-inch vertical turret lathe, motor driven.

Cincinnati Bickford Tool Co., Cincinnati, Ohio. 6-foot radial drill, 28-inch upright drill with tapping attachment.

Cincinnati Planer Co., Cincinnati, Ohio. 36-inch by 36-inch by 8-foot planer with Triumph-Monitor reversible motor drive.

Davis Boring Tool Co., St. Louis, Mo. Expansion boring tools for car wheels, turret lathes and turret boring mills.

Detroit Hoist & Machine Co., Detroit, Mich. Pneumatic and electric hoists and motors.

Eveland Engineering & Mfg. Co., Philadelphia, Pa. Electric riveters.

Goldschmidt Thermit Co., New York City. Materials and appliances used for welding by the thermit process.

Gould & Eberhardt, Newark, N. J. 28-inch shaper, and 12-inch hobbing machine, motor-driven.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Overhead trolley tracks, screw hoists, etc.

Independent Pneumatic Tool Co., Chicago, Ill. Piston air drills, pneumatic grinders, pneumatic hammers, etc.

International Oxygen Co., New York City. Oxygen and hydrogen producing equipment for autogenous welding and cutting.

Jessop & Son, Inc., Wm., New York City. Tool steels.

Landis Machine Co., Waynesboro, Pa. Bolt cutters; die heads, etc.

Landis Tool Co., Waynesboro, Pa. 16-inch by 6-foot plain grinding machine; No. 3 universal grinding machine.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. 24-inch by 10-foot engine lathe, motor-driven; 18-inch by 10-foot engine lathe, motor-driven.

Lucas Machine Tool Co., Cleveland, Ohio. No. 31 horizontal boring, drilling and milling machine with vertical milling attachment; No. 33 horizontal boring, drilling and milling machine.

Manning, Maxwell & Moore, Inc., New York City. Representing the Hendey Machine Co., Torrington, Conn. (lathes, centering machine and milling machine); J. N. Lapointe Co., New London, Conn. (broaching machines); Cincinnati Shaper Co., Cincinnati, Ohio (shaper and planer); National Machinery Co., Tiffin, Ohio (bolt cutters, nut tapping machines, etc.); Reed-Prentice Co., Worcester, Mass. (lathes).

Norton Co., Worcester, Mass. Grinding wheels.

Nuttall Co., R. D., Pittsburg, Pa. Cut gears.

Oxweld Railroad Service Co., Chicago, Ill. Oxy-acetylene cutting and welding apparatus.

Reed Mfg. Co., Erie, Pa. Machinists' vises.

Rich Tool Co., Chicago, Ill. High-speed drills and drilling machine.

Richmond Stay-Bolt Drilling Machine Mfg. Co., Richmond, Va. Stay-bolt drilling machines.

Ryerson & Son, Joseph T., Chicago, Ill. Samples of iron and steel.

Standard Roller Bearing Co., Philadelphia, Pa. Ball and roller bearings.

Vixen Tool Co., Philadelphia, Pa. "Vixen" files, and machine for resharpening "Vixen" files.

Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathes.

Watson-Stillman Co., New York City. Hydraulic power plant demonstrating vertical broaching, shearing rivets, etc.

Wiley & Russell Mfg. Co., Greenfield, Mass. Taps, dies, reamers, etc.

Wilmarth & Morman Co., Grand Rapids, Mich. Surface grinder and drill grinder.

Yale & Towne Mfg. Co., New York City. Electric and hand chain hoists, blocks, trolleys, etc.

* * *

A "Safety First" rally was held under the auspices of the New York Central Lines in Indianapolis, Ind., June 11 and Cincinnati, Ohio, June 12. About seven hundred employes were present at Indianapolis and over five hundred at Cincinnati. Addresses were delivered by Messrs. M. A. Neville, superintendent; Hadley Baldwin, superintendent; C. R. Meyers, chief claim agent; J. T. Luscombe, master mechanic; D. F. Schaff, superintendent; C. D. Miles, supervisor air brakes; and Marcus A. Dow, general safety agent New York Central Lines. Fifteen similar meetings have been held along the New York Central Lines since April, 1913, all of which have been well attended, and from the interest thus far displayed by the employes it appears that meetings of this character are a phase of the "Safety First" movement to which much attention and energy can be profitably devoted. The growth of sentiment for greater safety of railway operation is in remarkable contrast to the indifference with which accidents to railway employes were regarded a few years ago.

SAFEGUARDING THE INDUCTION MOTOR

It is an inherent characteristic of the squirrel cage type of induction motors to take a heavy starting current, ranging from three to seven times the full load current. This, in the case of large motors, may cause a serious drop of potential in the supply circuit, and to avoid trouble from this source, a starting compensator should be used. This device consists of an auto-transformer with taps for obtaining a reduced potential. A suitable mechanism is provided for momentarily connecting the motor to these taps for starting and then, when the motor has attained full speed, disconnecting it from the taps and throwing it directly on the supply circuit. The contacts are immersed to take advantage of making the break under oil to prevent burning the contacts and disturbances in the circuit. Starting compensators are not usually required for motors smaller than 7½ horsepower. The design and construction of the compensator is worked out in a way to insure the highest degree of dependability. The windings of the coils are thoroughly insulated to give a high factor of safety and to render a breakdown of the insulation practically impossible. The taps are brought out to provide a number of derived voltages sufficient for all conditions of service.

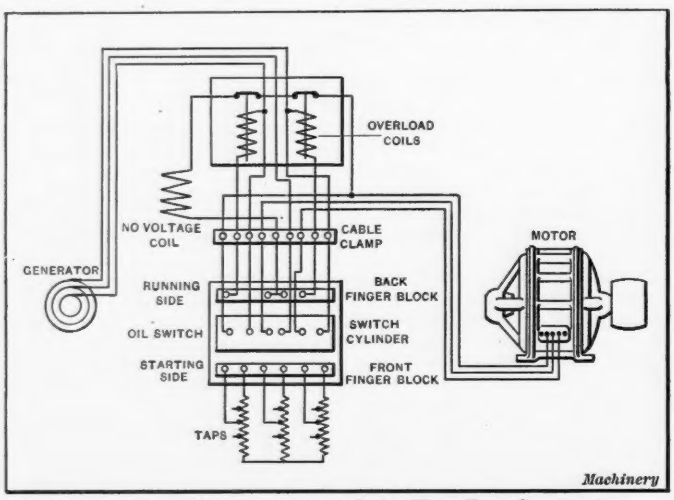


Diagram illustrating Construction of the Floor Type Compensator

The compensators for motors smaller than 18 horsepower have three taps giving 50, 65 and 80 per cent of the line voltage, with line currents, respectively, 25, 42 and 65 per cent of the current that would be taken by the motor if no compensator were used. For motors larger than 18 horsepower, the compensators are provided with four taps giving potentials equal to 40, 58, 70 and 85 per cent of the line voltage, and respective currents equal to 16, 34, 50 and 72 per cent of the current that would be taken by the motor if it were started direct from the line. After the motor has come up to the required speed, the handle must be thrown quickly to the "running position," the running contacts at the same time being taken care of automatically by the tension of springs which return the former to the "off" position. Lugs on the back of the lever arms prevent the contacts from moving further away than the "off" position.

To guard the motor from injurious overloads, all standard compensators listed for 110 to 550 volt induction motors are provided with fuses of the cartridge type mounted on a slate base and separated by barriers for from 1040 to 3000 volt motors. The compensators are provided with series, time limit, oil dashpot relay panels, enclosed by a dust-proof sheet iron cover, which shut down the motor if the overload stays on for an interval of time greater than that for which the dashpot is set.

Compensators of this type are made for all potentials up to and including 3000 volts, with a line current up to 400 amperes at 550 volts, and 200 amperes at 3000 volts. They are designed to bring the motors up to approximately full speed within one minute after the switch is thrown into the starting position. These compensators are made in two types, the suspension and the floor type. Suitable push buttons may be wired into the circuit of the no-voltage release coil to shut down the motor from a remote point if desired. The push button would normally be in the closed position. The overload relay has five calibration points, the lowest being the normal current of the motor and the highest 300 per cent of full load current. The compensators described in the preceding are manufactured by the General Electric Co., Schenectady, N. Y.

* * *

EARLY DEVELOPMENT OF BALL AND ROLLER BEARINGS

Endeavors to develop ball and roller bearings were made much earlier than is generally supposed. For instance, in building the old Trinity Church, Lancaster, Pa., a roller bearing was used to carry the heavy weather vane, weighing 150 pounds. This bearing was discovered in the year 1909, at which time repairs were made. Although it would not be considered a good example of machine and bearing construction today, it had held out under heavy service for a period of 115 years. The bronze spherical rollers, which in the beginning had a diameter of 1 3/16 inch, had worn down to 19/32 inch, while the races showed but little wear. Robert Fulton is supposed to have been the maker of this bearing; others ascribe it to Getz, the engraver of the Washington penny and the large seal of the United States. Trucks with axles mounted on rollers were submitted to the French Artillery Commission in 1795 or 1796. The political disturbances then rife in all probability caused this construction, which was not put to any practical use, to be forgotten. The Sayner Hütte (Foundry), in Sayne-Neuwied a. Rh., in 1845 had cranes equipped with ball bearings, and in 1847 the Bavarian Government Railroad made experiments with a roller bearing produced by Baron v. Rudoffer. In 1853 an American applied for a patent on a ball bearing of a peculiar construction, the outer race being made of hard rubber; it was not put into practical use, however. The German Patent Office in 1878 granted a patent on a ball bearing for a truck, to George Weckamp of Budapest. Krupp used ball bearings as early as 1871 in cranes and other machines, and, since 1885, in rotating naval gun carriages, but no far-reaching importance can be attributed to any of these forms of application. The use of ball bearings of commercial importance began with the development of the bicycle. Adjustable ball bearings for bicycles were patented by William Brown of England, in 1880, and ball bearings were first used on the Columbia high-wheel bicycle in that year.

* * *

THE "IMPERATOR"

The *Imperator*, the world's greatest steamer—for the time being—sailed from Hamburg June 11 and reached New York June 18. The length of this latest marvel of marine architecture is 919 feet, breadth 98 feet, depth 62 feet. Her displacement is 70,000 tons and registered tonnage 50,000 tons. The vessel is propelled by four screws driven by steam turbines having an aggregate power of 62,000 H. P. The rotor of one turbine weighs 135 tons, contains 50,000 blades and its casing is 25 feet long and 18 feet diameter. The shafts are 18 inches diameter and the propellers 16 feet diameter. The weight of the rudder alone is 90 tons and its stem is 30 inches diameter. The vessel was built for comfort and safety, no attempt being made to achieve excessive speed, the average speed for which she was designed being 22½ knots. The hull is divided into numerous water-tight compartments, there being twelve transverse bulkheads and one longitudinal bulkhead. A series of coal bunkers arranged along the sides of the ship and a double bottom give the *Imperator* a double skin, making her virtually "a ship within a ship." The life-saving equipment includes 83 life boats which will accommodate the maximum passenger list and the crew of 1100. Steadiness in a seaway is insured by the Frahm compensating tanks which dampen the roll of the vessel and reduce it to a minimum even in a heavy sea.

* * *

Recent tests of locomotive springs made from chrome-vanadium steel indicated that the elastic limit was reached at a stress of 256,000 pounds per square inch. Oil-tempered carbon steel springs showed an elastic limit of 101,000 pounds per square inch: chrome-nickel steel spring-tempered springs, an elastic limit of 134,500 pounds.

METHOD OF HOLDING PIECES TO BE FORGED

BY WILLIAM ROBERTS*

In holding a piece to be forged under a power hammer, there is a considerable shock at each stroke which is very hard on the man who is doing the work. The accompanying illustrations show two arrangements for holding work which relieve the workman of this strain. Referring to the illustrations, it will be seen that spring jaws are provided in which the work

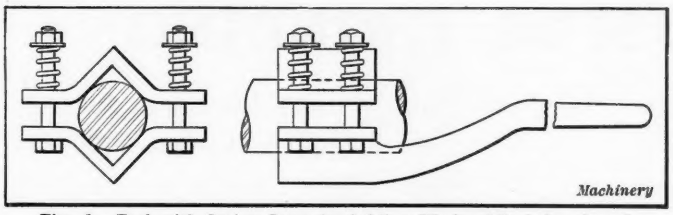


Fig. 1. Tool with Spring Jaws for holding Work while being forged

is held. The shock of the blow is absorbed by the springs instead of being passed on to the workman's arms.

It will be seen that the tool shown in Fig. 1 is provided with a single handle, and this device is intended for holding work that does not require to be frequently turned while forging. The tool in Fig. 2 is provided with four handles which are at an equal distance from each other. This tool is particularly adapted for classes of forging operations that require the piece to be continually turned. It will be evident that the operator

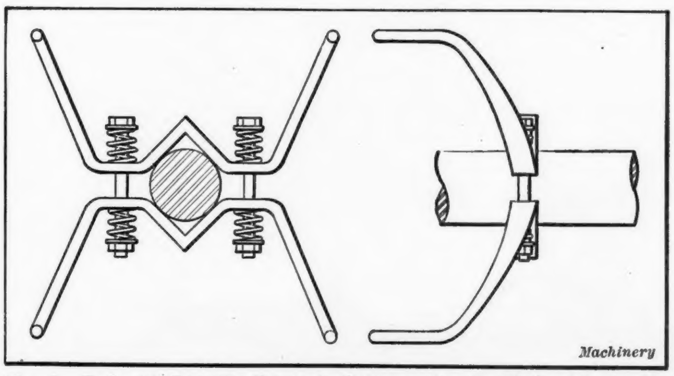


Fig. 2. Tool with Four Handles to facilitate turning the Work while forging

can change his grip from handle to handle and thus bring any surface of the work into position to receive the blow of the hammer. The dimensions of the tools have been omitted as the size will naturally depend upon the class of work for which they are to be used.

* * *

"BEVEL GEAR DRIVE FOR SHAFTS RUNNING IN THE SAME DIRECTION"-EXPLANATION

The statement was made in the letter "Bevel Gear Drive for Shafts Running in the Same Direction" by Francis W. Clough published in the June number that it possesses a valuable feature because of the possibility of locating one horizontal shaft above or below another and thus the advantage of a skew bevel gear could be obtained. The meaning was erroneously expressed. The author meant to suggest that shafts could be operated at other than 90 degrees with the combination; that one shaft might be horizontal and the other inclined to it in the vertical plane either at 90 degrees or any other angle required. The use of the term "skewed" was unfortunate as it conveyed the wrong impression.

* * *

The United States Civil Service Commission, Washington, D. C., will hold competitive examinations July 21 in certain principal cities throughout the United States for senior architect, senior inspector of car equipment, senior inspector of motive power, senior civil engineer, senior electrical engineer, senior structural engineer, senior railway signal engineer, and senior mechanical engineer. As a result of these examinations two grades of eligibles will be established, the salaries in the first grade ranging from $3000 to $4800 per annum, with necessary expenses when absent from headquarters in the discharge of official duties, and in the second grade from $1800 to $2700 and such expenses. Information as to where the examinations will be held can be obtained from the United States Civil Service Commission, Washington, D. C.

* Address: 218 Beach St., Revere, Mass.

* * *

A. S. M. E. EXCURSION TO GERMANY

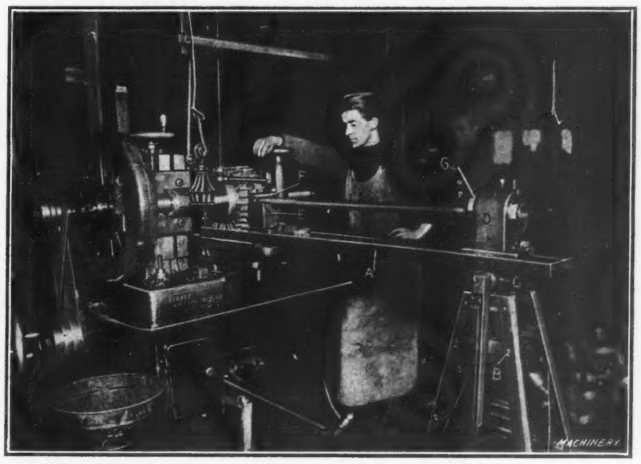
About two hundred and fifty members of the American Society of Mechanical Engineers, including ladies, sailed June 10 on the *Victoria Luise* for Hamburg, Germany, to take part in a joint meeting with the Verein Deutscher Ingenieure in Leipzig. Among those sailing were: W. N. Best, New York City; George M. Bond, Hartford, Conn.; Jacob S. Detrick, Baltimore, Md.; E. R. Fellows, Springfield, Vt.; Lester G. French, New York City; Arthur A. Fuller, Providence, R. I.; H. L. Gantt, New York City; Miss Kate Gleason, Rochester, N. Y.; James Hartness, Springfield, Vt.; Henry Hess, Philadelphia, Pa.; R. K. LeBlond, Cincinnati, Ohio; William Lodge, Cincinnati, Ohio; Henry M. Lucas, Cleveland, Ohio; J. W. Nelson, New York City; W. R. Warner, Cleveland, Ohio.

* * *

FIXTURE FOR MILLING PROPELLER SHAFTS

The accompanying illustration shows a fixture which is applied to a No. 7 Becker "Lincoln type" milling machine, for milling the square on the end of propeller shafts. The fixture consists of an auxiliary table *A* which is fastened by bolts to the regular table of the machine and is supported at its outer end by a stand *B* which is supplied with a roller *C*. This stand is held stationary, and the auxiliary table, of course, is free to slide back and forth when operated by the mechanism of the machine.

The propeller shaft which is 50¾ inches long is held in the special indexing fixture *D*, and is supported in a V-block *E* on the front end of the table in which it is clamped by the cross strip *F*. The nuts holding this strip, of course,



Milling Fixture used for milling the Square End on Propeller Shafts

have to be released before the work can be rotated for milling the remaining two sides of the square on the end of the shaft. The milling is accomplished by two 12-inch straddle milling cutters having thirty teeth made from high-speed steel. The square end on the shaft is 1¼ by 4¼ inches long and is cut down from the round bar 1½ inch in diameter in two cuts—that is one pass of the cutter completes two sides of the square. The indexing head, after the lock has been released, is rotated by the handle *G* shown projecting from the chuck, and is locked by a catch located in the opposite side of the fixture. This unique type of milling fixture is used in the plant of the Lewis Spring & Axle Co., Jackson, Mich.

* * *

"HEAT-TREATMENT OF GEARS AT THE BOSTON GEAR WORKS"—CORRECTION

The latter part of the second paragraph under "Kinds of Heat-treatment" in the article "Heat-treatment of Gears at the Boston Gear Works" published in the June number, should be

ine and the Work it is Doing

A RAPID PRODUCTION JOB

Phosphor bronze boxes for milling machine spindles. Ground externally on No. 14 Plain Grinding Machine. Larger diameter is straight, smaller diameter is taper and is ground to fit accurately in a hole in machine frame.

The ribs on these castings make *finish turning* difficult. The grinding machine finishes the rough turned castings not only to *closer limits* but *much quicker* than is possible on other machine tools.

This is but one example of what the No. 14 Plain Grinding Machine will do. It is capable of accuracy and speed on both light shafting and heavy reduction work.

Send for Further Information.

PROVIDENCE, R. I., U. S. A.

Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfort, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 75

corrected to read as follows: "These treatments cover steels with 0.10 to 0.60 per cent carbon; 31½ per cent, 5 per cent and 7 per cent nickel steels; nickel steel and chrome-vanadium steel of various carbon contents; and silico-manganese steels." Also under "Treatment Z" the third line should read "Reheat to 1450 to 1500 degrees F," and a fourth step should be added: "4. Quench in oil."

* * *

PERSONALS

John F. Winchester has taken a position with the Standard Oil Co., of New Jersey, as an automobile expert and oil salesman.

O. W. Gregg, formerly in charge of the power transmission department of Jones & Laughlin, Pittsburg, Pa., is now with the Chicago branch of the Saginaw Mfg. Co., and Gilbert Pulley Co.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., who recently underwent an operation for appendicitis at the Presbyterian Hospital, New York City, has fully recovered.

C. R. Chisholm, assistant to the master mechanic, Cristobal Marine Works, Canal Zone, has resigned from the service of the Isthmian Canal Commission to engage in the automobile business in Chicago.

Frank E. Shailor, a well-known contributor to MACHINERY, has resigned his position with the General Electric Co. at Pittsfield, Mass, to become works engineer of the American Electrical Heater Co., Detroit, Mich.

Albert H. Mitchel, formerly of the Chicago office of the Taft-Peirce Mfg. Co., Pawtucket, R. I., has succeeded Marcus M. Whipple as the New York sales representative of the company. The New York offices of the company are in the Woolworth Building.

J. F. Weeks has resigned from the engineering department of the American Mfg. Co., in order to become associated with C. S. Weeks, mechanical and consulting engineer, New York. This business will henceforth be conducted under the name of Weeks & Weeks.

John J. Grant, of the Grant Engineering Co., Detroit, Mich., will sail for a European business and pleasure trip July 8. Mr. Grant has been appointed consulting engineer by correspondence for the large automobile works of Clement & Co., of Paris, and also for the Austin Motor Works of Birmingham, England.

K. B. MacDonald, who for the past two years has been factory manager of the Russell Motor Car Co., Ltd., West Toronto, Canada, maker of Russell-Knight cars, has resigned. Mr. MacDonald was formerly associated with the E. R. Thomas Motor Car Co., of Buffalo, as factory manager. He has not yet announced his plans for the future.

John Calder, a well-known member of the American Society of Mechanical Engineers and an engineer of wide experience, has been elected president of the International Motor Co., with general offices in New York City. Mr. Calder was at one time executive engineer of the C. W. Hunt Co., and later manager of works and developer of the Remington typewriter industry at Ilion, N. Y., for nine years. He was later associate manager of the Cadillac Motor Car Co., at Detroit.

OBITUARIES

Bernhard Schuchardt, of Schuchardt & Schutte, died June 3 in Berlin, Germany.

Marcus M. Whipple, New York sales representative of the Taft-Peirce Mfg. Co., Pawtucket, R. I., died at his home in Newark, N. J., June 20, aged forty-nine years. Mr. Whipple was well and favorably known in the machinery trade.

Charles H. Cramp, former head of Wm. Cramp & Sons Ship & Engine Bldg. Co., Philadelphia, Pa., died at the home of his son in Philadelphia June 6, aged eighty-five years. Mr. Cramp was the son of William Cramp, the founder of the Cramp plant which was started on the Delaware River in 1830.

Dr. John T. Nicolson, professor of mechanical engineering, University of Manchester, England, and well-known investigator and writer on machine tool design, died March 27 at Macclesfield, England. Dr. Nicolson's book on lathe design, written in collaboration with Mr. Dempster Smith, is one of the most noteworthy contributions to the subject.

CONTENTS FOR JULY

The first column of page numbers applies to the Engineering Edition; the second to the Shop Edition

COMING EVENTS

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

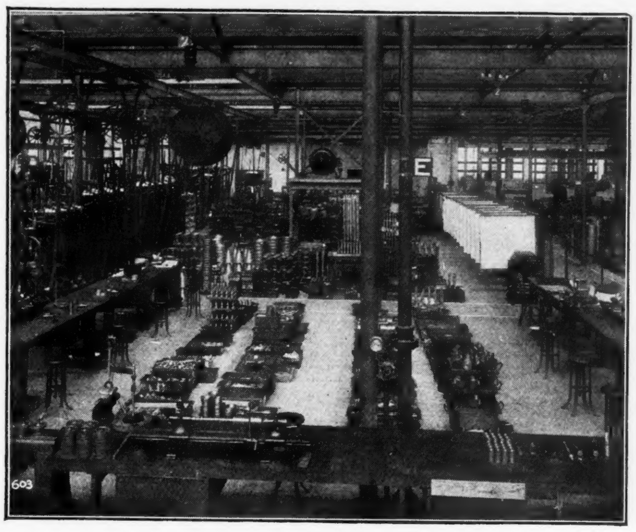
September 1-4.—A meeting of the Iron and Steel Institute at Brussels, Belgium. G. C. Lloyd, secretary, 28 Victoria St., London, S. W., England.

September 17-23.—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

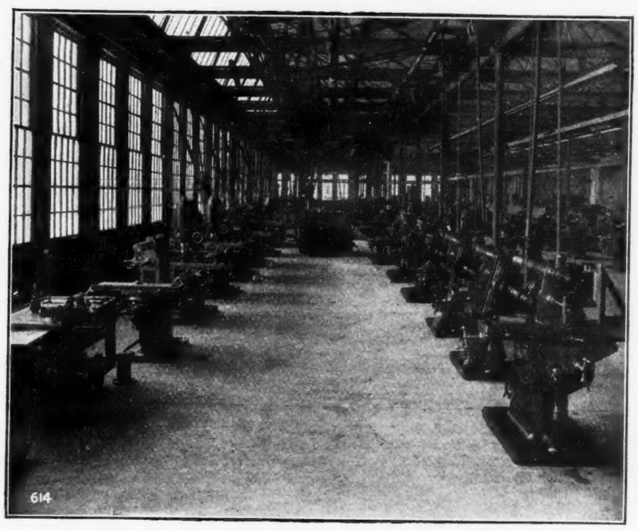
October 10-17.—Eighth Annual Foundry & Machine Exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.



Inspection and Routing Department.

Department for Assembling and Testing Feed and Drive Boxes.



Department for Testing the Completed Machines.

EVERY DETAIL OF CINCINNATI MILLERS

is inspected after every operation. Some of them pass through this department as many as twenty times before they are finished. Hardened gears, clutches, and similar parts are also tested with the scleroscope and must meet definite standards of hardness set for each piece.

The drive box, feed box, etc., each forms a complete unit of mechanism. They are assembled by skilled men who are expert on this work because they do nothing else.

Every unit when assembled is given a running test under working conditions before passing into stock.

The completed machine must pass an exacting inspection for alignment; must run continuously for a given period; and must also do a variety of milling successfully.

These running and working tests are a final check on each unit of mechanism, and are a guarantee that every detail is fully up to our high standard of excellence.

These are some of our Manufacturing Methods. Visit us and see them for yourself.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerloffs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

October 19-25.—Seventh Annual Convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Illinois, Urbana, Ill., dedicated the new transportation building and locomotive and mining laboratories May 8 and 9. The transportation building is a fireproof structure 143 feet long and 65 feet wide. The locomotive laboratory is a brick and steel structure 117 feet long by 43 feet wide. The mounting mechanism for receiving the locomotives to be tested is of original design and of such capacity as to give accommodation to the largest locomotive yet built, not excepting those of the Mallet type.

American Society of Agricultural Engineers, I. W. Dickerson, secretary, Urbana, Ill., announces that the society is now ready to furnish technical assistance in the management of a competition of general purpose tractors. The president of the society, Mr. L. W. Chase, has appointed a special committee to advise and assist in the technical management of the competition. Rules and regulations governing the contest and supervising the testing and judging of the tractors will be furnished. The rapidly growing importance of tractors for agricultural purposes, etc., should make the work of the society of exceptional engineering value and interest.

International Engineering Congress will be held in San Francisco, Cal., in 1915, in connection with the Panama-Pacific International Exposition. The congress is to be conducted under the auspices of the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers. These societies, acting in cooperation, have appointed a permanent committee of management, consisting of the presidents and secretaries of each of these societies and eighteen members resident in San Francisco. W. F. Durand is chairman of the committee of management, with offices in the Foxcroft Building, San Francisco.

NEW BOOKS AND PAMPHLETS

Government Coal Purchases Under Specifications. By George S. Pope and Joseph D. Davis. 96 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin No. 41.

The Properties of Saturated and Superheated Ammonia Vapor. By G. A. Goodenough, and William Earl Mosher. 94 pages, 6 by 9 inches. Published by the University of Illinois Experiment Station, Urbana, Ill. Price, 50 cents.

The Evaporation Test for Mineral Lubricating and Transformer Oils. By C. E. Waters. 13 pages, 7 by 10 inches. Published by the Department of Commerce and Labor, Washington, D. C., as No. 13 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Action of the Salts in Alkali Water and Sea Water on Cements. By P. H. Bates, A. J. Phillips and Rudolph J. Wig. 157 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 12 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Scientific Road Construction. 31 pages, 6 by 9 inches. Illustrated. Published as Bulletin No. 5 by the Department of Asphaltum, Standard Oil Co. of California.

The bulletin is of interest to all concerned with good roads. It gives the reasons for road failures and treats of the advantages of asphaltum as a road-making material when incorporated with broken rock.

Industrial Arts Index—A Cumulative Index to Engineering and Trade Periodicals. 6¾ by 9¾ inches. Published by the H. W. Wilson Co., Minneapolis, Minn.

The index is issued five times a year and each number is cumulated for the year to date of issue. The December number will contain the annual cumulation. The contents of all magazines reviewed are indexed by author and under as many subject heads as the contents demand. This plan of subject indexing brings articles on any one subject to one place in the alphabet and cross references make easy the finding of material on allied subjects.

Tests of Reinforced Concrete Buildings Under Load. By Arthur N. Talbot and Willis A. Slater. 104 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 64. Price 50 cents.

The bulletin gives a detailed description of the methods developed at the University of Illinois for measuring stresses produced in steel and concrete in reinforced buildings under load. By the use of measuring apparatus, the minute stretches and shortenings which occur in the beams, columns and floor slabs of a reinforced concrete building while under load, were measured. The results of the tests on three large buildings located in three cities are recorded. The data obtained are of a character to permit a discussion of the correctness of the methods of design and of the mathematical formulas in use. The bulletin is of special use to engineers, structural designers and architects, and is of general interest to manufacturers contemplating the erection of concrete structures.

NEW CATALOGUES AND CIRCULARS

C. & C. Electric & Mfg. Co., Garwood, N. J. Bulletin 513C on electric arc welding apparatus.

New Jersey Foundry & Machine Co., 90 West St., New York City. Circular of cranes, tracks, trolleys, and hoists.

James Clark, Jr., Electric Co., Louisville, Ky. Circular of "Willey" electrically-driven sensitive drills and grinders.

Spray Engineering Co., 201 Devonshire St., Boston, Mass. Bulletin No. 51 illustrating and describing "air washers."

Edgemont Machine Co., 2700 National Ave., Dayton, Ohio. Catalogue "E" describing several new types of friction clutches.

Gardner Governor Co., Quincy, Ill. Catalogue of Gardner-Rix vertical air compressors and Gardner horizontal air compressors.

Bullard Machine Tool Co., Bridgeport, Conn. Circular descriptive of the new turret head of the Bullard vertical turret lathe.

W. L. Brubaker & Bros., Millersburg, Pa. Catalogue of taps, dies, reamers, special tools, screw plates, pipe stocks, end mills, etc.

American Brass Co., Ansonia, Conn. Booklet on "Tobin" bronze, containing data on tensile, torsional, crushing and corrosive tests.

Steel Specialties Co., 66 Woerd Ave., Waltham, Mass. Leaflet on the new Worth clamp wedge washer, a nut lock and washer combined.

Lennox Throatless Shear Co., Marshalltown, Iowa. Circular of the Lennox throatless shear for cutting straight and serpentine shapes from sheet metal.

Chambersburg Engineering Co., Chambersburg, Pa. Wall calendar for 1913 illustrating examples of hydraulic machinery for every variety of forging.

Keuffel & Esser Co., Hoboken, N. J. Circular of the Smith fountain drawing pen which eliminates the time lost through constantly refilling drawing pens.

Baldwin Locomotive Works, Philadelphia, Pa. Record Nos. 73 and 74, on "Recent Development of the Locomotive" and "Gasoline Locomotives," respectively.

International Oxygen Co., 115 Broadway, New York City. Booklet illustrating a number of oxygen and hydrogen plants in operation installed by the company.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 127, on pneumatic drills, reamers, wood borers, flue rolling and tapping machines and grinders.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Bulletin 119 on selective-head engine lathes built in 14-, 16-, 18-, 20-, 22-, 24-, 27-, 30-, 36-, 42-, and 48-inch sizes.

Richmond Stay-Bolt Drilling Machine Mfg. Co., Richmond, Va. Catalogue of multiple spindle semi-automatic stay-bolt drills for drilling detector holes in the ends of locomotive stay-bolts.

De Laval Steam Turbine Co., Trenton, N. J. Pamphlet of 108 pages on the De Laval steam turbine, containing valuable and interesting data for those interested in steam turbine equipment for power plants.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Catalogue No. 521 on Sprague steel-armored hose for railroad air brakes, steam heating tender hose and pneumatic hose.

Bristol Co., Waterbury, Conn. Bulletins 143 and 173 on Bristol recording differential pressure gages, bulletin 170 on soldering iron electric furnaces and catalogue 1300 on Bristol Class III recording thermometers.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet illustrating office buildings, municipal buildings, hotels, department stores, and other buildings in Chicago, equipped with Cutler-Hammer apparatus for controlling motors, etc.

Norton Co., Worcester, Mass. Health Bulletins Nos. 1 to 12 issued by the Norton Co.'s medical department for the information and guidance of workmen. These health bulletins contain much practical and valuable health information.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletins Nos. 128, 132 and 133 on miscellaneous equipment for pneumatic drills, pneumatic motors and pneumatic geared hoists, and cylinder air hoists and jacks, respectively.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Circular of Hisey tool-post grinders; parallel and internal grinders; hand and breast drills; feed-screw drills; portable and aerial grinders and buffers; Scotch radial drills, all electrically operated.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet on Dixon's graphite brushes for electric generators and motors. Directions are given for using brushes under various conditions of service, and other valuable information is included.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue of "Brownhoist" locomotive cranes containing many fine halftone illustrations of equipment furnished to railroads, manufacturers, contractors, etc., in all parts of the country.

Whitman & Barnes Mfg. Co., Akron, Ohio. Folder illustrating the company's line of twist drills, easy starting arbors, fluted shell reamers, taper shank jobbers' reamers, taper bridge reamers, expansion reamers, roughing reamers, chucking reamers, etc.

Cling Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet entitled "Is There Rosin in Cling-Surface?", containing reports from chemists showing that no rosin is contained in the belt preparation known as "Cling-Surface." A list of prominent users is also given.

Flexible Steel Lacing Co., Chicago, Ill. Circular of steel lacing for machine belting which provides a rocker hinged joint. The lacing is provided with "alligator" teeth, to engage the belt fabric, and is easily and quickly applied to leather, canvas or rubber belting.

Rockford Machine Tool Co., Rockford, Ill. Circular of the Rockford No. 44 vertical milling machine having capacity of 44 inches table feed, 16½ inches cross feed, and 19 inches vertical feed. This machine has a non-adjustable knee, the spindle being mounted in a vertical slide.

Asbestos Protected Metal Co., Beaver Falls, Pa. Circular of asbestos protected metal for roofing, siding, etc., of manufacturing plants. The material consists of metal sheet covered with a protective coating to prevent rust, over which is applied the asbestos surfacing.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular of Garvin cam or form milling machines of 6, 12, 24 and 36 inches capacity. The line of form milling machines illustrated covers a wide range and variety of cam and form milling, embracing both disk and barrel cams.

Beaudry & Co., 141 Milk St., Boston, Mass. Booklet on Beaudry power hammers built in two types: The "Champion" for light and heavy railroad, machine and general forging, and the "Peerless" for plating, drawing, swaging, collaring, spindle-making and general manufacturing.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa. Pamphlet on fuel costs, being a comparison of the cost of burning fuel oil, producer gas, natural gas and powdered coal in furnaces. The data contained is of interest to all concerned with the operation of heating furnaces for metal treatment.

Queen City Machine Tool Co., Cincinnati, Ohio. Circular of the Queen City plain cylindrical grinder, 12 and 14 inches swing, 36, 48, 60, 72 inches and up, between centers. The features of this grinder are all steel gears, centralized control, large protected bearings, massive and self-contained design, good lubrication, etc.

Dodge Mfg. Co., Mishawaka, Ind. Folder entitled "Over-the-Seas," illustrating how Dodge transmission machinery is packed and crated for foreign shipment. This important detail of marketing goods abroad has been thoroughly worked out by the Dodge people, and very substantial crating is provided for all goods shipped abroad.

Ideal Casehardening Compound Co., United States Rubber Bldg., New York City. Fifth edition of treatise on casehardening and heat-treating steel, containing much useful information and many practical rules. This little treatise, which is sent to any address on application, will be found very useful by all concerned with the heat-treatment of steel.

J. Faessler Mfg. Co., Moberly, Mo. Catalogue illustrating and describing the Faessler line of boiler tools, comprising several types of hand-operated and power-driven roller flue expanders, sectional beading expanders, flue cutters, patch bolt countersinking tools, etc. The new Faessler safety sectional expander with quick-acting knock-out is shown.

Cooper Hewitt Electric Co., Hoboken, N. J. Pamphlet on industrial lighting, illustrating shops, mills and factories illuminated with a Cooper Hewitt light, and containing a general discussion of illumination, conditions of distinct vision, effect of glare, faults of individual lighting, cause of industrial accidents, importance of diffusion, effect of color on distinctness of vision, etc.

McKenna Bros. Brass Co., Pittsburg, Pa. Circular of the Keen impact ball tester for testing the hardness of steels. This simple device combines some of the features of the Brinell and Shore instruments for testing. It substitutes dynamic force for static force to impress a hardened ball into the material to be tested and measures the width of the indentation with a special form of scale.

Julius King Optical Co., 10-12 Maiden Lane, New York City and 7 W. Madison St., Chicago, Ill. Catalogue on King safety goggles for use in steel mills, foundries, factories, etc., where workmen's eyes are endangered by flying particles. These goggles, known as the "Saniglas," are fitted with the strongest, toughest glass that can be manufactured. While the glass may be fractured, it holds together and very seldom shatters.

Sprague Electric Works of the General Electric Co., 527-531 West 34th St., New York City. Circular of Sprague electric equipment for printing machinery; Catalogue 439 on Sprague conduit products, comprising stamped steel boxes and covers, multilets, G. E. receptacles, switches, sockets and rosettes, flexible steel conduits (galvanized), rigid conduits, watertight floor outlet boxes, cast-iron outlet and junction boxes, etc.

Structural Card Index Systems. E. R. Monroe, manager, 512-514 Phoenix Block, Bay City, Mich. Catalogue of card index systems for cast-iron columns, steel plates, standard angles of even legs, standard angles of uneven legs, channels and I-beams, cast-iron plates, requisition blanks, flexible leather covers, etc. These structural card index systems are being used by manufacturers, engineers, architects and others, with satisfaction.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn. Circular of the No. 2½ five-spindle full automatic. The company has purchased the patents and manufacturing rights covering the Universal screw machine formerly made by the Universal Machine Screw Co., of Hartford, Conn. This screw machine, with the line of Prentice chucking machines for castings, forgings and second operation work, completes a line of multiple-spindle automatics covering a wide range of work.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34L on general pneumatic engineering information, containing instructions for intending purchasers, air compressor data, quarrying and mining data, general pneumatic tool data

necessary for estimates and advice, tables of volumes, mean pressures, temperatures, etc., in the operation of air compression from one atmosphere and 60 degrees F.; table of efficiencies of air compression at different altitudes; table of density of gases and vapors; tables of single compression and two-stage compression at altitudes, etc.

Baird Machine Co., Bridgeport Conn. "Baird's Paper Model," a booklet illustrating the Baird system of automatic attachments for presses. One page is ingeniously arranged with cut-out patterns which can be folded over the central illustration and thus show the appearance of the attachments when in place. The attachments comprise: side roll feed, transfer attachment, dial attachment and back roll feed, all of which can be applied to the Baird plain single-action open-back press, and can be purchased when required. The booklet also illustrates the attachments applied with the main part of the press in phantom, and gives specifications.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletins Nos. 101, 201, 301, 401, 501, 901, 1101, 1201, 1301, 1401, 1501, 2001 and 2020, on portable electric drills, hand and breast types; Scotch radial drills for direct and alternating currents; electric sensitive bench and floor drills for direct and alternating currents; electric drilling and tenoning machine for direct and alternating currents; portable electric drills, heavy-duty types, 1½ to 2½ inches capacity for direct and alternating currents; portable electric reamers for direct current; electric toolpost grinders for direct and alternating currents; "Hisey" parallel and internal grinders for direct and alternating currents; bench grinders for direct and alternating currents; portable and aerial surface grinders for direct and alternating currents; Hisey electric flexible shaft tools for direct and alternating currents; Hisey electric blocking and polishing machines for direct and alternating currents; and Hisey electric beveling machine for direct and alternating currents, respectively.

Pennsylvania Railroad Co., Philadelphia, Pa. Safety booklet containing hints and suggestions for the prevention of personal injury and accidents under the following general heads: "Right-of-Way Including Right-of-Way Structures," "Operation," "Unsafe Practices," "Electrical," "Transportation," "Sanitary Conditions," "Hygiene," "First Aid," "Trespassing," "General Suggestions for Safeguarding Machinery and Shop Conditions, Applicable to All Plants," etc. The general manager, S. C. Long, in distributing these booklets makes the following appeal: "The business of transportation requires that more than ordinary precaution shall be taken to safeguard operation from accidents, and while in all railroad operations the safety of passengers is the first consideration, the problems presented in protecting its employes in many respects are identical, and in safeguarding the latter the safety of the public is also largely secured. Safety in railroad operation is not a question of safeguards, but of intelligent caution constantly exercised. The ultimate aim of the safety work is to develop in each employe a sense of personal responsibility, not alone in taking measures for his own safety, but for that of his fellow employe as well."

TRADE NOTES

Bay State Tap & Die Co., Mansfield, Mass., has erected two one-story brick additions to its factory, each sixty feet long by thirty feet wide.

Boulet's Fine Tool Works, Inc., formerly at Beverly, Mass., maker of indicators and other tools for machinists, toolmakers, etc., has removed to Sebago Lake, Maine.

International Motor Co., general offices Broadway and 57th St., New York City, at a recent meeting of the board of directors elected John Calder president, in place of C. P. Coleman, resigned. Robert E. Fulton was elected vice-president and F. R. Phillips was appointed assistant to the president.

American Pulley Co., Philadelphia, Pa., has issued a statement regarding the origin of steel pulleys. Thomas Corscaden is said to have been the first to make pulleys exclusively of steel. About 1895 he exhibited a model of what was shortly to become known as the "American" steel split pulley.

Morton Mfg. Co., Muskegon Heights, Mich., has entirely rebuilt its manufacturing plant, erecting a steel frame and putting on a new roof. The reconstructed plant incorporates all modern improvements, such as traveling cranes, sanitary toilets, wash basins, etc. A considerable amount of new machine equipment will be installed.

Queen City Machine Tool Co., Cincinnati, Ohio, manufacturer of shapers and plain grinders, has recently made extensive alterations and additions to its plant, thus increasing its capacity sixty per cent. The changes and additions were made necessary owing to the fact that the company is placing a new cylindrical grinder on the market. It is expected that deliveries of the new grinder will be made about October 1.

Hindley Gear Co., 1105 Frankford Ave., Philadelphia, Pa., is a concern recently incorporated under the laws of Pennsylvania to manufacture worm gearing of the Hindley type. The new company takes over that branch of the business of the Otis Elevator Co. The move has been made necessary by the heavily increased demand from the automobile trade for the Hindley worm gear axles for commercial trucks.

Van Dorn Electric Tool Co., Cleveland, Ohio, has been formed to take care of the portable tool department of the Van Dorn & Dutton Co., of Cleveland. The reason for forming a separate company to take care of the portable tool business has been the rapid growth of this department, as well as of the regular gear cutting department. The Van Dorn & Dutton Co. will be devoted entirely to the gear cutting business in the future.

Quigley Furnace & Foundry Co., Springfield, Mass., has purchased the good will, drawings, patterns and patents of the Rockwell Furnace Co., New York City, and will continue the manufacture of the full line of Rockwell furnaces with the exception of the melting furnaces, portable heaters, rivet forges, etc. These will be marketed by the Monarch Engineering & Mfg. Co., Baltimore, Md., which has thus added the Rockwell melting line to its present line of furnaces. Orders for repair parts, etc., will be given prompt attention by these companies.

Clipper Belt Lacer Co., Grand Rapids, Mich., has a new plant operated on the piece price system and profit sharing plan. The new plan has materially increased its output and has increased the employes' pay more than 20 per cent. In this connection, it is interesting to note that every one of the employes and all the officers of the company were subscribers to the $250,000 fund for a new Y. M. C. A. building. The case illustrates the possibility of operating a manufacturing plant in such a manner as to stimulate the employes' interest in humanitarian work and local improvements, generally—in other words to make them good citizens as well as good employes.

Wright Wrench & Forging Co., Canton, Ohio, manufacturer of wrenches and drop forgings, has made additions to its plant of buildings and equipment, including a 600-ton steam hydraulic forging press. The company is now prepared to promptly furnish pressed or hammered forgings such as single, double and up to six-throw crankshafts, engine shafts, cam shafts, marine shafts, crusher shafts, armature shafts, piston-rods, connecting-rods, bending rolls, marine forgings, locomotive forgings, driving, tender and car axles, large rounds and squares and miscellaneous forgings of all kinds made from open-hearth chrome-nickel or vanadium steel. These forgings will be furnished either rough-forged, smooth-forged, rough-machined or finished. The company is in a position to scientifically heat-treat all alloy steels.

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—I

Gage	Thickness in Inches	$\frac{1}{16}$-inch	$\frac{1}{8}$-inch	$\frac{3}{16}$-inch	$\frac{1}{4}$-inch	$\frac{5}{16}$-inch	$\frac{3}{8}$-inch	$\frac{7}{16}$-inch	$\frac{1}{2}$-inch
0000000	0.5000	0.1063	0.2126	0.3189	0.4252	0.5315	0.6378	0.7441	0.8504
000000	0.4688	0.0996	0.1992	0.2988	0.3984	0.4980	0.5976	0.6972	0.7968
00000	0.4375	0.0930	0.1860	0.2790	0.3720	0.4650	0.5580	0.6510	0.7440
0000	0.4063	0.0864	0.1728	0.2592	0.3456	0.4320	0.5184	0.6048	0.6912
000	0.3750	0.0797	0.1594	0.2391	0.3188	0.3985	0.4782	0.5579	0.6376
00	0.3438	0.0731	0.1462	0.2193	0.2924	0.3655	0.4386	0.5117	0.5848
0	0.3125	0.0664	0.1328	0.1992	0.2656	0.3320	0.3984	0.4648	0.5312
1	0.2813	0.0598	0.1196	0.1794	0.2392	0.2990	0.3588	0.4186	0.4784
2	0.2656	0.0565	0.1130	0.1695	0.2260	0.2825	0.3390	0.3955	0.4520
3	0.2500	0.0531	0.1062	0.1593	0.2124	0.2655	0.3186	0.3717	0.4248
4	0.2344	0.0498	0.0996	0.1494	0.1992	0.2490	0.2988	0.3486	0.3984
5	0.2188	0.0465	0.0930	0.1395	0.1860	0.2325	0.2790	0.3255	0.3720
6	0.2031	0.0432	0.0864	0.1296	0.1728	0.2160	0.2592	0.3024	0.3456
7	0.1875	0.0399	0.0798	0.1197	0.1596	0.1995	0.2394	0.2793	0.3192
8	0.1719	0.0365	0.0730	0.1095	0.1460	0.1825	0.2190	0.2555	0.2920
9	0.1563	0.0332	0.0664	0.0996	0.1328	0.1660	0.1992	0.2324	0.2656
10	0.1406	0.0299	0.0598	0.0897	0.1196	0.1495	0.1794	0.2093	0.2392
11	0.1250	0.0266	0.0532	0.0798	0.1064	0.1330	0.1596	0.1862	0.2128
12	0.1094	0.0233	0.0466	0.0699	0.0932	0.1165	0.1398	0.1631	0.1864
13	0.0938	0.0199	0.0398	0.0597	0.0796	0.0995	0.1194	0.1393	0.1592
14	0.0781	0.0166	0.0332	0.0498	0.0664	0.0830	0.0996	0.1162	0.1328
15	0.0703	0.0149	0.0298	0.0447	0.0596	0.0745	0.0894	0.1043	0.1192
16	0.0625	0.0133	0.0266	0.0399	0.0532	0.0665	0.0798	0.0931	0.1064
17	0.0563	0.0120	0.0240	0.0360	0.0480	0.0600	0.0720	0.0840	0.0960
18	0.0500	0.0106	0.0212	0.0318	0.0424	0.0530	0.0636	0.0742	0.0848
19	0.0438	0.0093	0.0186	0.0279	0.0372	0.0465	0.0558	0.0651	0.0744
20	0.0375	0.0080	0.0160	0.0240	0.0320	0.0400	0.0480	0.0560	0.0640
21	0.0344	0.0073	0.0146	0.0219	0.0292	0.0365	0.0438	0.0511	0.0584
22	0.0313	0.0067	0.0133	0.0201	0.0268	0.0335	0.0402	0.0469	0.0536
23	0.0281	0.0060	0.0120	0.0180	0.0240	0.0300	0.0360	0.0420	0.0480
24	0.0250	0.0053	0.0106	0.0159	0.0212	0.0265	0.0318	0.0371	0.0424
25	0.0219	0.0047	0.0094	0.0141	0.0188	0.0235	0.0282	0.0329	0.0376
26	0.0188	0.0040	0.0080	0.0120	0.0160	0.0200	0.0240	0.0280	0.0320
27	0.0172	0.0037	0.0074	0.0111	0.0148	0.0185	0.0222	0.0259	0.0296
28	0.0156	0.0033	0.0066	0.0099	0.0132	0.0165	0.0198	0.0231	0.0264
29	0.0141	0.0030	0.0060	0.0090	0.0120	0.0150	0.0180	0.0210	0.0240
30	0.0125	0.0027	0.0054	0.0081	0.0108	0.0135	0.0162	0.0189	0.0216
31	0.0109	0.0023	0.0046	0.0069	0.0092	0.0115	0.0138	0.0161	0.0184
32	0.0102	0.0022	0.0044	0.0066	0.0088	0.0110	0.0132	0.0154	0.0176
33	0.0094	0.0020	0.0040	0.0060	0.0080	0.0100	0.0120	0.0140	0.0160
34	0.0086	0.0018	0.0036	0.0054	0.0072	0.0090	0.0108	0.0126	0.0144
35	0.0078	0.0017	0.0034	0.0051	0.0068	0.0085	0.0102	0.0119	0.0136
36	0.0070	0.0015	0.0030	0.0045	0.0060	0.0075	0.0090	0.0105	0.0120
37	0.0066	0.0014	0.0028	0.0042	0.0056	0.0070	0.0084	0.0098	0.0112
38	0.0063	0.0013	0.0026	0.0039	0.0052	0.0065	0.0078	0.0091	0.0104

Contributed by G. W. Linn

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—II

Gage	$\frac{9}{16}$-inch	$\frac{5}{8}$-inch	$\frac{11}{16}$-inch	$\frac{3}{4}$-inch	$\frac{13}{16}$-inch	$\frac{7}{8}$-inch	$\frac{15}{16}$-inch	1-inch	2 inches
0000000	0.9567	1.0630	1.1693	1.2756	1.3819	1.4882	1.5945	1.7008	3.4016
000000	0.8964	0.9960	1.0956	1.1952	1.2948	1.3944	1.4940	1.5936	3.1872
00000	0.8370	0.9300	1.0230	1.1160	1.2090	1.3020	1.3950	1.4880	2.9760
0000	0.7776	0.8640	0.9500	1.0368	1.1232	1.2096	1.2960	1.3824	2.7648
000	0.7173	0.7970	0.8767	0.9564	1.0361	1.1158	1.1955	1.2752	2.5504
00	0.6579	0.7310	0.8041	0.8772	0.9505	1.0234	1.0965	1.1696	2.3392
0	0.5976	0.6640	0.7300	0.7968	0.8632	0.9296	0.9960	1.0624	2.1248
1	0.5382	0.5980	0.6578	0.7176	0.7774	0.8372	0.8970	0.9568	1.9136
2	0.5085	0.5650	0.6215	0.6780	0.7345	0.7910	0.8475	0.9040	1.8080
3	0.4779	0.5310	0.5841	0.6372	0.6903	0.7434	0.7965	0.8496	1.6992
4	0.4482	0.4980	0.5478	0.5976	0.6474	0.6972	0.7470	0.7968	1.5936
5	0.4185	0.4650	0.5115	0.5580	0.6045	0.6510	0.6975	0.7440	1.4880
6	0.3888	0.4320	0.4752	0.5184	0.5616	0.6048	0.6480	0.6912	1.3824
7	0.3591	0.3990	0.4389	0.4788	0.5187	0.5586	0.5985	0.6384	1.2768
8	0.3285	0.3650	0.4015	0.4380	0.4745	0.5110	0.5475	0.5840	1.1680
9	0.2988	0.3320	0.3652	0.3984	0.4316	0.4648	0.4980	0.5312	1.0624
10	0.2691	0.2990	0.3289	0.3588	0.3887	0.4186	0.4485	0.4784	0.9568
11	0.2394	0.2660	0.2926	0.3192	0.3458	0.3724	0.3990	0.4256	0.8512
12	0.2097	0.2330	0.2563	0.2796	0.3029	0.3262	0.3445	0.3728	0.7456
13	0.1791	0.1990	0.2189	0.2388	0.2587	0.2786	0.2985	0.3184	0.6368
14	0.1494	0.1660	0.1826	0.1992	0.2158	0.2324	0.2490	0.2656	0.5312
15	0.1341	0.1490	0.1639	0.1788	0.1937	0.2086	0.2235	0.2384	0.4768
16	0.1197	0.1330	0.1463	0.1596	0.1729	0.1862	0.1995	0.2128	0.4256
17	0.1080	0.1200	0.1320	0.1440	0.1560	0.1680	0.1800	0.1920	0.3840
18	0.0954	0.1060	0.1166	0.1272	0.1378	0.1484	0.1590	0.1696	0.3392
19	0.0837	0.0930	0.1023	0.1116	0.1209	0.1302	0.1395	0.1488	0.2976
20	0.0720	0.0800	0.0880	0.0960	0.1040	0.1120	0.1200	0.1280	0.2560
21	0.0657	0.0730	0.0803	0.0876	0.0949	0.1022	0.1095	0.1168	0.2336
22	0.0603	0.0670	0.0737	0.0804	0.0871	0.0938	0.1005	0.1072	0.2144
23	0.0540	0.0600	0.0660	0.0720	0.0780	0.0840	0.0900	0.0960	0.1920
24	0.0477	0.0530	0.0583	0.0636	0.0689	0.0742	0.0795	0.0848	0.1696
25	0.0423	0.0470	0.0517	0.0564	0.0611	0.0658	0.0705	0.0752	0.1504
26	0.0360	0.0400	0.0440	0.0480	0.0520	0.0560	0.0600	0.0640	0.1280
27	0.0333	0.0370	0.0407	0.0444	0.0481	0.0518	0.0555	0.0592	0.1184
28	0.0297	0.0330	0.0363	0.0396	0.0429	0.0462	0.0495	0.0528	0.1056
29	0.0270	0.0300	0.0330	0.0360	0.0390	0.0420	0.0450	0.0480	0.0960
30	0.0243	0.0270	0.0297	0.0324	0.0351	0.0378	0.0405	0.0432	0.0864
31	0.0207	0.0230	0.0253	0.0276	0.0299	0.0322	0.0345	0.0368	0.0736
32	0.0198	0.0220	0.0242	0.0264	0.0286	0.0308	0.0330	0.0352	0.0704
33	0.0180	0.0200	0.0220	0.0240	0.0260	0.0280	0.0300	0.0320	0.0640
34	0.0162	0.0180	0.0198	0.0216	0.0234	0.0252	0.0270	0.0288	0.0576
35	0.0153	0.0170	0.0187	0.0204	0.0221	0.0238	0.0255	0.0272	0.0544
36	0.0135	0.0150	0.0165	0.0180	0.0195	0.0210	0.0225	0.0240	0.0480
37	0.0126	0.0140	0.0154	0.0168	0.0182	0.0196	0.0210	0.0224	0.0448
38	0.0117	0.0130	0.0143	0.0156	0.0169	0.0182	0.0195	0.0208	0.0416

Contributed by G. W. Linn

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—III

Gage	3 inches	4 inches	5 inches	6 inches	7 inches	8 inches	9 inches	10 inches	11 inches
0000000	5.1024	6.8032	8.5040	10.2048	11.9056	13.6064	15.3072	17.0080	18.7088
000000	4.7808	6.3744	7.9680	9.5616	11.1552	12.7488	14.3424	15.9360	17.5296
00000	4.4640	5.9520	7.4400	8.9280	10.4160	11.9040	13.3920	14.8800	16.3680
0000	4.1472	5.5296	6.9120	8.2944	9.6768	11.0592	12.4416	13.8240	15.2064
000	3.8256	5.1008	6.3760	7.6512	8.9264	10.2016	11.4768	12.7520	14.0272
00	3.5088	4.6784	5.8480	7.0176	8.1872	9.3568	10.5264	11.6960	12.8656
0	3.1872	4.2496	5.3120	6.3744	7.4368	8.4992	9.5616	10.6240	11.6864
1	2.8704	3.8272	4.7840	5.7408	6.6976	7.6544	8.6112	9.5680	10.5248
2	2.7120	3.6160	4.5200	5.4240	6.3280	7.2320	8.1360	9.0400	9.9440
3	2.5488	3.3984	4.2480	5.0976	5.9472	6.7968	7.6464	8.4960	9.3456
4	2.3904	3.1872	3.9840	4.7808	5.5776	6.3744	7.1712	7.9680	8.7648
5	2.2320	2.9760	3.7200	4.4640	5.2080	5.9520	6.6960	7.4400	8.1840
6	2.0736	2.7648	3.4560	4.1472	4.8384	5.5296	6.2208	6.9120	7.6032
7	1.9152	2.5536	3.1920	3.8304	4.4688	5.1072	5.7456	6.3840	7.0224
8	1.7520	2.3360	2.9200	3.5040	4.0880	4.6720	5.2560	5.8400	6.4240
9	1.5936	2.1248	2.6560	3.1872	3.7184	4.2496	4.7808	5.3120	5.8432
10	1.4352	1.9136	2.3920	2.8704	3.3488	3.8272	4.3056	4.7840	5.2624
11	1.2768	1.7024	2.1280	2.5536	2.9792	3.4048	3.8304	4.2560	4.6816
12	1.1184	1.4912	1.8640	2.2368	2.6096	2.9824	3.3552	3.7280	4.1008
13	0.9552	1.2736	1.5920	1.9104	2.2288	2.5472	2.8656	3.1840	3.5024
14	0.7968	1.0624	1.3280	1.5936	1.8592	2.1248	2.3904	2.6560	2.9216
15	0.7152	0.9536	1.1920	1.4304	1.6688	1.9072	2.1456	2.3840	2.6224
16	0.6384	0.8512	1.0640	1.2768	1.4896	1.7024	1.9152	2.1280	2.3408
17	0.5760	0.7680	0.9600	1.1520	1.3440	1.5360	1.7280	1.9200	2.1120
18	0.5088	0.6786	0.8480	1.0276	1.1872	1.3572	1.5264	1.6960	1.8656
19	0.4464	0.5952	0.7440	0.8928	1.0416	1.1904	1.3192	1.4880	1.6368
20	0.3840	0.5120	0.6400	0.7680	0.8960	1.0240	1.1520	1.2800	1.4080
21	0.3504	0.4672	0.5840	0.7008	0.8176	0.9344	1.0512	1.1680	1.2848
22	0.3216	0.4288	0.5360	0.6432	0.7504	0.8576	0.9648	1.0720	1.1792
23	0.2880	0.3840	0.4800	0.5760	0.6720	0.7680	0.8640	0.9600	1.0560
24	0.2544	0.3392	0.4240	0.5088	0.5936	0.6784	0.7632	0.8480	0.9328
25	0.2256	0.3008	0.3760	0.4512	0.5264	0.6016	0.6768	0.7520	0.8272
26	0.1920	0.2560	0.3200	0.3840	0.4480	0.5120	0.5960	0.6400	0.7040
27	0.1776	0.2368	0.2960	0.3552	0.4144	0.4736	0.5328	0.5920	0.6512
28	0.1584	0.2112	0.2640	0.3168	0.3696	0.4224	0.4752	0.5280	0.5808
29	0.1440	0.1920	0.2400	0.2880	0.3360	0.3840	0.4320	0.4800	0.5280
30	0.1296	0.1768	0.2160	0.2592	0.3024	0.3536	0.3888	0.4320	0.4752
31	0.1104	0.1472	0.1840	0.2208	0.2576	0.2974	0.3312	0.3680	0.4048
32	0.1056	0.1408	0.1760	0.2112	0.2464	0.2816	0.3168	0.3520	0.3872
33	0.0960	0.1280	0.1600	0.1920	0.2240	0.2560	0.2880	0.3200	0.3520
34	0.0864	0.1152	0.1440	0.1728	0.2016	0.2304	0.2592	0.2880	0.3168
35	0.0816	0.1088	0.1360	0.1632	0.1904	0.2176	0.2448	0.2720	0.2992
36	0.0720	0.0960	0.1200	0.1480	0.1680	0.1920	0.2160	0.2400	0.2640
37	0.0674	0.0896	0.1120	0.1348	0.1568	0.1792	0.2016	0.2240	0.2464
38	0.0624	0.0832	0.1040	0.1248	0.1456	0.1664	0.1872	0.2080	0.2288

Contributed by G. W. Linn

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—IV

Gage	12 inches	13 inches	14 inches	15 inches	16 inches	17 inches	18 inches	19 inches	20 inches
0000000	20.4096	22.1104	23.8112	25.5120	27.2128	28.9136	30.6144	32.3152	34.0160
000000	19.1232	20.7168	22.3104	23.9040	25.4976	27.0912	28.6848	30.2784	31.8720
00000	17.8560	19.3440	20.8320	22.3200	23.8080	25.2960	26.7840	28.2720	29.7600
0000	16.5888	17.9712	19.3536	20.7360	22.1184	23.5008	24.8832	26.2656	27.6480
000	15.3024	16.5776	17.8528	19.1280	20.4032	21.6784	22.9536	24.2288	25.5040
00	14.0352	15.2048	16.3744	17.5440	18.7136	19.8832	21.0528	22.2224	23.3920
0	12.7488	13.8112	14.8736	15.9360	16.9984	18.0608	19.1232	20.1856	21.2480
1	11.4816	12.4384	13.3952	14.3520	15.3088	16.2656	17.2224	18.1792	19.1360
2	10.8480	11.7520	12.6560	13.5600	14.4640	15.3680	16.2720	17.1760	18.0800
3	10.1952	11.0448	11.8944	12.7440	13.5936	14.4432	15.2928	16.1424	16.9920
4	9.5616	10.3584	11.1552	11.9520	12.7488	13.5456	14.3424	15.1392	15.9360
5	8.9280	9.6720	10.4160	11.1600	11.8040	12.6480	13.3920	14.1360	14.8800
6	8.2944	8.9856	9.6768	10.3680	11.0592	11.7504	12.4416	13.1328	13.8240
7	7.6608	8.2992	8.9376	9.5760	10.2144	10.8528	11.4912	12.1296	12.7680
8	7.0080	7.5920	8.1760	8.7600	9.3440	9.9280	10.5120	11.0960	11.6800
9	6.3744	6.9056	7.4368	7.9680	8.4992	9.0304	9.5616	10.0928	10.6240
10	5.7408	6.2192	6.6976	7.1760	7.6544	8.1328	8.6112	9.0896	9.5680
11	5.1072	5.5328	5.9584	6.3840	6.8096	7.2352	7.6608	8.0864	8.5120
12	4.4736	4.8464	5.2192	5.5920	5.9648	6.3376	6.7104	7.0832	7.4560
13	3.8208	4.1392	4.4576	4.7760	5.0944	5.4128	5.7312	6.0496	6.3680
14	3.1872	3.4528	3.7184	3.9840	4.2496	4.5152	4.7808	5.0464	5.3120
15	2.8608	3.0992	3.3376	3.5760	3.8144	4.0528	4.2912	4.5296	4.7680
16	2.5536	2.7664	2.9792	3.1920	3.4048	3.6176	3.8304	4.0432	4.2560
17	2.3040	2.4960	2.6880	2.8800	3.0720	3.2640	3.4560	3.6480	3.8400
18	2.0352	2.2048	2.3744	2.5440	2.7144	2.8832	3.0568	3.2224	3.3920
19	1.7856	1.9344	2.0832	2.2320	2.3808	2.5296	2.6784	2.8272	2.9760
20	1.5360	1.6640	1.7920	1.9200	2.0480	2.1760	2.3040	2.4320	2.5600
21	1.4016	1.5184	1.6352	1.7520	1.8688	1.9856	2.1024	2.2192	2.3360
22	1.2864	1.3936	1.5008	1.6080	1.7152	1.8084	1.9296	2.0368	2.1440
23	1.1520	1.2480	1.3440	1.4400	1.5360	1.6320	1.7280	1.8240	1.9200
24	1.0176	1.1024	1.1872	1.2720	1.3568	1.4416	1.5264	1.6112	1.6960
25	0.9024	0.9776	1.0528	1.1280	1.2032	1.2784	1.3536	1.4288	1.5040
26	0.7680	0.8320	0.8960	0.9600	1.0240	1.0880	1.1920	1.2160	1.3800
27	0.7104	0.7696	0.8288	0.8880	0.9472	1.0064	1.0656	1.1248	1.1840
28	0.6336	0.6864	0.7392	0.7920	0.8448	0.8976	0.9504	1.0032	1.0560
29	0.5760	0.6240	0.6720	0.7200	0.7680	0.8160	0.8640	0.9120	0.9600
30	0.5184	0.5616	0.6048	0.6480	0.7072	0.7344	0.7776	0.8208	0.8640
31	0.4416	0.4784	0.5152	0.5520	0.5948	0.6256	0.6624	0.6992	0.7360
32	0.4224	0.4576	0.4928	0.5280	0.5632	0.5984	0.6336	0.6688	0.7140
33	0.3840	0.4160	0.4480	0.4800	0.5120	0.5440	0.5760	0.6080	0.6400
34	0.3456	0.3744	0.4032	0.4320	0.4608	0.4896	0.5184	0.5472	0.5760
35	0.3264	0.3596	0.3808	0.4080	0.4352	0.4624	0.4896	0.5168	0.5440
36	0.2960	0.3120	0.3360	0.3600	0.3840	0.4080	0.4320	0.4560	0.4800
37	0.2796	0.2912	0.3136	0.3360	0.3584	0.3808	0.4032	0.4256	0.4480
38	0.2496	0.2704	0.2912	0.3120	0.3328	0.3536	0.3744	0.3952	0.4160

Contributed by G. W. Linn